[illegible]

ARIABLE	LABEL	N	SUM
	STATE=TEXAS		
SHWATER	WATER + SMLLAK - MARIN - GTLAK - SLTLAK	254	3516.223034
ATER	CENSUS WATER GREATER THAN 40 ACRES	254	5214.080031
MLLAKE	UNIV. OF IOWA WATER LESS THAN 40 ACRES	254	713.914370
ARINE	INLAND MARINE WATER	254	2411.771367
TLAKE	INLAND GREAT LAKE WATERS	254	0.000000
LTLAKE	SIZEABLE SALINE LAKES	254	0.000000
REA	TOTAL SURFACE AREA	254	267333.192777
	STATE=UTAH		
SHWATER	WATER + SMLLAK - MARIN - GTLAK - SLTLAK	29	1005.1881723
ATER	CENSUS WATER GREATER THAN 40 ACRES	29	2526.0440905
MLLAKE	UNIV. OF IOWA WATER LESS THAN 40 ACRES	29	22.4667953
ARINE	INLAND MARINE WATER	29	0.0000000
TLAKE	INLAND GREAT LAKE WATERS	29	0.0000000
LTLAKE	SIZEABLE SALINE LAKES	29	1543.3227136
REA	TOTAL SURFACE AREA	29	84914.1351075
	STATE=VERMONT		
SHWATER	WATER + SMLLAK - MARIN - GTLAK - SLTLAK	14	385.03971406
ATER	CENSUS WATER GREATER THAN 40 ACRES	14	341.45745136
MLLAKE	UNIV. OF IOWA WATER LESS THAN 40 ACRES	14	43.58226250
ARINE	INLAND MARINE WATER	14	0.00000000
TLAKE	INLAND GREAT LAKE WATERS	14	0.00000000
LTLAKE	SIZEABLE SALINE LAKES	14	0.00000000
REA	TOTAL SURFACE AREA	14	9609.75463594
	STATE=VIRGINIA		
SHWATER	WATER + SMLLAK - MARIN - GTLAK - SLTLAK	100	972.0295531
ATER	CENSUS WATER GREATER THAN 40 ACRES	100	1033.5207544
MLLAKE	UNIV. OF IOWA WATER LESS THAN 40 ACRES	100	113.3604954
ARINE	INLAND MARINE WATER	100	174.9521674
TLAKE	INLAND GREAT LAKE WATERS	100	0.0000000
LTLAKE	SIZEABLE SALINE LAKES	100	0.0000000
REA	TOTAL SURFACE AREA	100	40834.0005562
	STATE=WASHINGTON		
SHWATER	WATER + SMLLAK - MARIN - GTLAK - SLTLAK	39	1443.2570490
ATER	CENSUS WATER GREATER THAN 40 ACRES	39	1623.5010531
MLLAKE	UNIV. OF IOWA WATER LESS THAN 40 ACRES	39	217.5656261
ARINE	INLAND MARINE WATER	39	397.7775422
TLAKE	INLAND GREAT LAKE WATERS	39	0.0000000
LTLAKE	SIZEABLE SALINE LAKES	39	0.0000000
REA	TOTAL SURFACE AREA	39	68177.3146967

STATE WATER AREA FIGURES

ARIABLE	LABEL	N	SUM
	------------------------- STATE=WEST VIRGINIA -------------------------		
SHWATER	WATER + SMLLAK - MARIN - GTLAK - SLTLAK	55	185.9234453
ATER	CENSUS WATER GREATER THAN 40 ACRES	55	111.6197031
MLLAKE	UNIV. OF IOWA WATER LESS THAN 40 ACRES	55	74.3037422
ARINE	INLAND MARINE WATER	55	0.0000000
TLAKE	INLAND GREAT LAKE WATERS	55	0.0000000
LTLAKE	SIZEABLE SALINE LAKES	55	0.0000000
REA	TOTAL SURFACE AREA	55	24180.4724219
	------------------------- STATE=WISCONSIN -------------------------		
SHWATER	WATER + SMLLAK - MARIN - GTLAK - SLTLAK	72	2080.9813309
ATER	CENSUS WATER GREATER THAN 40 ACRES	72	1710.6937437
MLLAKE	UNIV. OF IOWA WATER LESS THAN 40 ACRES	72	387.4130516
ARINE	INLAND MARINE WATER	72	0.0000000
TLAKE	INLAND GREAT LAKE WATERS	72	17.1254644
LTLAKE	SIZEABLE SALINE LAKES	72	0.0000000
REA	TOTAL SURFACE AREA	72	56152.7566656
	------------------------- STATE=WYOMING -------------------------		
SHWATER	WATER + SMLLAK - MARIN - GTLAK - SLTLAK	23	1107.4558667
ATER	CENSUS WATER GREATER THAN 40 ACRES	23	319.9395750
MLLAKE	UNIV. OF IOWA WATER LESS THAN 40 ACRES	23	787.5162917
ARINE	INLAND MARINE WATER	23	0.0000000
TLAKE	INLAND GREAT LAKE WATERS	23	0.0000000
LTLAKE	SIZEABLE SALINE LAKES	23	0.0000000
REA	TOTAL SURFACE AREA	23	97912.3402567

chapter 2. The creation of these density measures is straightforward and consists of dividing the water area by surface area (SURFAREA) yielding a value between zero and one. Since there are several different types of water area, there are also several different density measures which could be used. The various density measures can be used as the lambda parameter, or expected value of the Poisson distribution, hence the various density variables created are accordingly denoted as a capital L and underscore followed by an indication of the type of water area used. The five density measures are based on the area of estuaries and bays (L_ESBAYS), freshwater (L_FRESH), INLAND WATER (L_INLND), saltwater (L_SALT) and all water (L_WATER).

Unfortunately, this still leaves us one step away from the measures ultimately needed for estimation, namely the area of water suitable for fishing, boating or swimming by county. If the fraction of water in a county that is suitable for various forms of water-based recreation could be determined, these figures could be applied to the area values we already have to produce a supply variable specific to marine or freshwater fishing, boating or swimming. Our research has not uncovered county by county estimates of recreation limitations for the entire nation. Since we have been unable to find information on the area of recreation-suitable water by county, we will assume that the county fractions are the same as the state fractions. This assumption still allows us to account for the fact that some counties within a state have less water in total than other counties even though it does not allow us to capture the distribution of recreation-suitable waters within a state. See appendix 5.B on water quality survey for pollution fractions by state.

Parks & Facilities - Availability

A county facilities inventory available from the Solar Energy Research Institute covers the following 25 categories:

National Parks, acreage
State Parks, acreage
Snow Ski Areas
Swimming
Fishing, acreage
Natural, acreage
Archery, Shooting, positions
Tennis, number of courts
Hunting, acreage
Trails, miles
Boating
Camp Grounds, measured by # of sites
Golf Courses
Camping: Day, acreage
Camping: Vacation, acreage
Camping: Long Term, acreage
Recreational Resorts, acreage
National Forests, acreage
Grasslands, number
Marinas, number of slips
Indian Reservations
Historical, Archeological Sites
Amusement Parks
Museums
Urban Parks & Recreation Facilities

An examination of the SERI survey revealed, however, that most categories have no physical unit of measurement (acres, miles, number of sites) and were thus of little use in characterizing county-level facility supply.

CLIMATE

The climate data, taken from the Geoecology database, were collected by the National Climatic Data Center (NCDC, a branch of the National Oceanic and Atmospheric Administration) in Asheville, North Carolina. The data are presented in "norms," the NCDC convention to reduce the effect of fluctuation in measures over the years. Norms are calculated for thirty year periods and are updated every ten years. Data now available is for norms covering the years 1951 to 1980, though Geoecology presents the 1941 to 1970 norms. The various norms presented in Geoecology are for the average, maximum and minimum temperature and precipitation, for each month of the year as well as annually.

To calculate the norm, for example, for the average temperature for the month of July, the July monthly average temperature for the thirty data points between 1941 and 1970 are averaged. The monthly average is the mean of the daily means (the median of daily high and low). The norm for average precipitation is the mean of 30 years' data on total monthly (or annual) precipitation. The maximum (or minimum) norm for temperature is the 30 year average of the monthly average of daily high (or low) temperature, thus the average norm is also the average of the maximum and minimum norms, for temperature. Maximum and minimum precipitation norms are meaningless, if defined in a similar way since the measurement of precipitation is on a monthly basis. The maximum and minimum "norms" for precipitation that are presented in Geoecology appear to be the maximum and minimum monthly (or annual precipitation values for the 30 year period, instead of norms as previously defined. Therefore (contrary to the case of temperature), the average of the maximum and minimum "norms" is <u>not</u> the average norm when discussing precipitation. Also, the monthly values do not sum to the annual value for the maximum and minimum precipitation "norms" as they do for the average precipitation norm. NCDC does not publish a data series on maximum and minimum norms for precipitation.

The data covers the 48 contiguous states at the State Climatic Division (SCD) level. There are 353 SCD's describing areas within a state which save similar climate conditions, as defined by the National Weather Service. Generally, SCD's follow county lines, but may not in the case of a mountainous region. Where an entire county falls within an SCD, it has been assigned the values for that SCD in the Supply Variables Database. Counties which are part of more than one SCD are assigned the average of the values for SCD's which cover the county, weighted by the county area in each SCD. While this method may produce some unrealistic data (because of mountainous areas), this is the only way to produce full county coverage of the climate data. County level data was provided in Geocology for the eastern United States. However, since many counties do not have weather stations, this data includes some interpolated values. Those counties which are part of more than one SCD are assigned a value of one for the variable SCD_FLAG, to signal potentially unrealistic data. The following list shows the number of affected counties by state.

California	24	New York	16
Colorado	16	Oregon	16
Connecticut	5	Pennsylvania	1
Idaho	31	South Carolina	3
Maine	12	South Dakota	30
Massachusetts	7	Utah	22
Michigan	2	Vermont	10
Nevada	3	Washington	31
New Hampshire	1	West Virginia	8
New Jersey	5	Wyoming	17
New Mexico	21	Total	281

The naming convention used for the climate variables in the Supply Variables Database is as follows. The first three letters designate the month of the year or whether it is the annual norm. Following the underscore is either a "P" or a "T," standing for precipitation and temperature, respectively. The last three letters designate whether the measure is an average, maximum or minimum. Altogether, there are 79 different climate variables, including SCD_FLAG and those listed below. Also shown below are formulas for calculating the norms using the data measured at monitors, which includes HIGH and LOW, the daily high and low temperatures, and RAIN, total rainfall. All temperatures are in degrees Fahrenheit, and precipitation is measured in inches.

Temperature Variables			Precipitation Variables		
Average	Maximum	Minimum	Average	Maximum	Minimum
JAN_TAVE	JAN_TMAX	JAN_TMIN	JAN_PAVE	JAN_PMAX	JAN_PMIN
FEB_TAVE	FEB_TMAX	FEB_TMIN	FEB_PAVE	FEB_PMAX	FEB_PMIN
MAR_TAVE	MAR_TMAX	MAR_TMIN	MAR_PAVE	MAR_PMAX	MAR_PMIN
APR_TAVE	APR_TMAX	APR_TMIN	APR_PAVE	APR_PMAX	APR_PMIN
MAY_TAVE	MAY_TMAX	MAY_TMIN	MAY_PAVE	MAY_PMAX	MAY_PMIN
JUN_TAVE	JUN_TMAX	JUN_TMIM	JUN_PAVE	JUN_PMAX	JUN_PMIN
JUL_TAVE	JUL_TMAX	JUL_TMIN	JUL_PAVE	JUL_PMAX	JUL_PMIN
AUG_TAVE	AUG_TMAX	AUG_TMIN	AUG_PAVE	AUG_PMAX	AUG_PMIN
SEP_TAVE	SEP_TMAX	SEP_TMIN	SEP_PAVE	SEP_PMAX	SEP_PMIN
OCT_TAVE	OCT_TMAX	OCT_TMIN	OCT_PAVE	OCT_PMAX	OCT_PMIN
NOV_TAVE	NOV_TMAX	NOV_TMIN	NOV_PAVE	NOV_PMAX	NOV_PMIN
DEC_TAVE	DEC_TMAX	DEC_TMIN	DEC_PAVE	DEC_PMAX	DEC_PMIN
ANN_TAVE	ANN_TMAX	ANN_TMIN	ANN_PAVE	ANN_PMAX	ANN_PMIN

OTHER VARIABLES

The lone accessibility variable comes from Geoecology. The ROADS_77 value includes the area of all 1977 federal and state roads. This variable could be included in a recreation participation model to account for ease of accessibility. Also the latitude (LATITUDE) AND LONGITUDE (LNGITUDE) of the county centroid are included. These variables are useful in calculating distances based on the sweep program (see appendix 5.A).

State-Level Data

Many of the variables described already can be easily aggregated to a state-level variable. For example, the FRSH_WAT values for all counties sum to SFRSHWAT, while the SURFAREA values sum to SSURFARE. Thus a new density value for the entire state, SL_FRESH, is calculated by dividing SFRSHWAT by SSURFARE. This is tantamount to taking an area-weighted average of the county values of L_FRESH. However, some of the variables are not so easily aggregated. This is particularly true of the climate data. As such, the database is supplemented by state-level data on several other characteristics. Additional climate variables include WINDSPD, SUNSHINE, and HDEG DAYS. These are respectively defined as, average windspeed, average percentage of possible sunshine, and annual heating degree days. The data for all three variables is taken from the Statistical Abstract of the United States.

Two other supply type variables which are included are FF_DBAG, the average freshwater fishing daily bag, and LARGESLK, the size of the largest lake in the state. The fishing bag variable is taken from the earlier work on freshwater fishing by Vaughan and Russell (1982), while the data on largest lakes is from Bue (1963).

Other state level data includes the state average cost per gallon of gasoline for 1975, COSTPGAL (Federal Energy Administration, 1976). Also, 1972 and 1977 data on a state price index developed by Fuchs, Michael and Scott (1979) is included as PHICKS72 and PHICKS77 variables. The 1975 level of the state general sales tax rate is included as the SALESTAX variable.

Table 5.D.2 lists more detailed descriptions of the county-level supply variables.

Table 5.D.2. County-level Supply Variables (Non-Climate)

Variable	Description	Source
AREA_77	Surface area of county not including water other than inland water, 1977, sq. mi.	Geoecology (<u>County Statistics</u>)
BRACKWA	Inland brackish water area as included in census water, sq. mi.	USGS maps
CENS_WAT	Census water area, including lakes and ponds greater than 40 acres, and rivers and streams 1/8 mile or more in width and estuaries and bays defined as inland (where headlands are less than 1 mile, or islands from a border with all breaks less than one mile, 1977, sq. mi.	Geoecology (<u>County Statistics</u>)
CO_AREA	County area, including land area and area of small lakes (<40 acres) and mall rivers (<1/8 mile wide), 1972 county borders, sq. mi.	Geoecology (<u>1972 county and City DB</u>)
COASTAL	Code density coastal status of county, as follows: 0 No appreciable saltwater 1 North Atlantic 2 South Atlantic 3 Gulf of Mexico 4 Pacific 5 Great Lakes 6 Principal saline lake	USGS maps
COUNTY	County name	Geoecology
FIPS	5 digit Federal Information Processing Standard Code, uniquely identifying counties by combined state and county code	Geoecology
FIPS_CO	3 digit county FIPS code identifying counties within a state	Geoecology
FIPS_ST	2 digit state FIPS code identifying the state a county is in	Geoecology

Table 5.D.2 (Continued)

FRSH_WAT	County freshwater area including small freshwater bodies not measured by census water, in sq. mi., equal to: (ENS_WAT + SML_LAKE_BRACKWA	Geoecology (County Statistics) USGS maps
GTLKESBA	Great Lake estuary and bay area which is included in census water, sq. mi. Equal to: BRACKWA, if COASTAL = 5 0, otherwise	USGS maps
INLNDWAT	Area of inland water (fresh and brackish) of county, sq. mi. Equal to: = CENS_WAT + SML_LAKE = WATER_LGESBAYS = FRSH_WAT + SMESBAYS + GTLKESBA + SALTLAKE	Geoecology USGS maps
LAND	Land area corrected for area of small lakes and ponds (<40 acres) and small rivers and streams (<1/8 mile wide), 1977, sq. mi.	Geoecology (County Statistics)
LAND_77	Land area, 1977, inventoried by USDA, including small lakes and rivers	Geoecology (County Statistics)
LATITUDE	Latitude of county centroid	Geoecology
LNGITUDE	Longitude of county centroid	Geoecology
ROADS_77	Area of federal and state roads, 1977, sq. mi.	Geoecology (County Statistics)
SALTLAKE	Principal saline lake area which is included in Census of inland water, (see CENS_WAT), sq. mi. Equal to: BRACKWA, if COASTAL = 6 0, otherwise	USGS maps
SMESBAYS	Area of small estuaries and bays which is included in Census measure of inland water (see CENS WAT), sq. mi. Equal to: BBACKWA, if COASTAL = 1,2,3,or 4 0, otherwise	USGS maps

Table 5.D.2 (Continued)

LGESBAYS	Area of Large estuaries and bays not included in census county water or area measures, often called water other than inland water, 1960 state-wide measures apportioned to counties, sq. mi.	Area Measurement Reports, maps
SML_LAKE	Area of small water bodies not included in Census inland water (lakes and ponds less than 40 acres each and rivers and streams less than 1/8 mile wide), corresponding to 1970 counties, measured by Iowa State, sq. mi.	Geoecology (County Statistics)
STATE	State name	Geoecology
SURFAREA	Total surface area of county, including land and all water (large estuaries and bays are included in counties), sq. mi., Equal to: AREA_77 + LGESDAYS	Geoecology (County Area Measurement Reports, maps
TOTESBAY	Total marine estuaries and bay area, sq. mi., Equal to: LGESBAYS + SMESBAYS	Area Measurement Reports, USGS maps
URBAN_77	Area of urban land in county, 1977, sq. mi.	Geoecology (County Statistics)
WATER	Area of all water, the total fresh and brackish by county and water not elsewhere classified as belonging to particular counties ("water other than inland water"), Equal to: FRSH_WAT + SMESBAYS + LGESBAYS + GTLKESBA + SALTLAKE	Geoecology (County Statistics), USGS maps, Measurement Reports
L_ESBAYS	Unitless measure of sprinkle of estuary and bay water bodies, calculated as: (TOTESDAY + GTLKESBA)/SURFAREA	
L_FRESH	Traction of county surface area covered by freshwater or, unitless sprinkle of freshwater by county, calculated by FRSH_WAT/SURFAREA	

Table 5.D.2 (Continued)

L_INLAND	Fraction of county surface area covered by inland water bodies, both fresh and brackish, calculated by INLNDWAT/SURFAREA
L_SALT	Fraction of county surface area covered by salt water bodies calculated by (SALTLAKE + GTLKESBA + LGESBAYS)/SURFAREA
L_WATER	Fraction of county surface area covered by any water body WATER/SURFAREA

NOTES

1. Personal Communication with Dr. Robert Durland of the Census Bureau's Geography Division.

2. See McNulty, et. al., 1972; Crance, 1971; Christmas, 1973; Diener 1975; and Perret, 1971.

3. See Newspaper Enterprise Association, 1982; Bue, 1963; and Leeden, 1975.

4. A planimeter is an engineering instrument that measures the area of irregular shapes when the planimeter arm is moved around the perimeter of the shape.

5. Conversation with Dr. Merle Van Horne of the U.S. Park Service Heritage Conservation and Recreation Service.

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Chapter 6

GREAT LAKES AND SALTWATER RECREATIONAL FISHING: PARTICIPATION PROBABILITY AND INTENSITY

This chapter discusses the results of estimating our models of participation probability and intensity for saltwater and Great Lakes recreational fishing. The data used were described in chapter 5, and the groundwork for the general two-step method laid in chapter 3. For a variety of reasons, only a few alternatives could be explored at the estimation stage, and for the most part these produce consistent results. One small problem of interpretation will be seen to crop up. But in the following chapter a more serious difficulty will arise, when projections are made of the effect of water pollution control. In all cases the models estimated include availability variables reflecting the diminution due to pollution as well as other causes. These we shall refer to occasionally as net availability measures. [1]

PROBABILITY MODEL ESTIMATION:

Dependent Variables

The three dependent variables are GLFISH, INSHFISH, and DEEPFISH as described in chapter 5. Each is a 0/1 variable, where 0 represents no participation, and 1 participation, in Great Lakes fishing, inshore saltwater fishing, and offshore saltwater fishing, respectively. Means and standard deviations were given in chapter 5, table 5.2. One noteworthy characteristic of these variables is the small number of participants in the activities, ranging from 1.2% of the total sample for Great Lakes fishing (GLFISH) to about 7.5% for inshore saltwater fishing. This is not surprising, in light of both the specialized nature of the activities and the fairly large distances between many individuals' homes and a suitable water body. It does imply, however, that changes in participation in any of the three activities will apply to a small base, especially in comparison with freshwater fishing, where about 25-30 percent of the population already claimed to participate pre-policy. Assuming small incremental changes in the availability variables, this means that benefits due to pollution reduction are likely to be modest, even without data or methodological problems.

INDEPENDENT VARIABLES

The socio-economic variables are quite straightforward. As with the dependent variables, variable names, definitions, means and standard deviations were shown in chapter 5. METRO has a mean of 0.415, which is considerably lower than that of the U.S. population at large, reflecting the peculiarities of the original telephone survey sample design. We used the natural logs of age and income, rather than natural units, in an attempt to account for the non-linearity frequently found with these variables in previous empirical work. The most commonly used alternative to the logarithmic transformation, namely power functions (AGE^2, AGE ,...) would have resulted in extreme multi-collinearity. Heating Degree Days (HDD) and its interaction with METRO (HDDM) were included as proxies for length of fishing season. It should be noted that these values were for an individual's home county rather than for inferred destination.

The availability measures require somewhat more explanation. For expository purposes, they can be divided into "coastal" water availability and "local" freshwater availability. The first category includes GLDIST, INSHDIST, and DEEPDIST, and their respective interactions with METRO (See table 5-2). These distances are all "corrected" to account for both unavailability due to pollution and other causes, such as shoreline obstructions. The difference between INSHDIST and DEEPDIST arises because Dyson obtained both an "inshore" marine pollution measure and an "offshore" marine pollution measure from state officials. The differences between these two are incorporated into INSHDIST and DEEPDIST. (Note that the "uncorrected" distance is the same for both).

For local freshwater measures, we calculated availability at two different levels of geographic aggregation--state and county--and used two different transformations--acres of freshwater per acre of total surface area (a_w/a_t) and the distance proxy $(a_w/a_t)^{-0.5}$. Our original intention was to include all of the coastal availability measures--GLDIST, INSHDIST, DEEPDIST, and their METRO interactions--and either state or county level local freshwater measures, using either the a_w/a_t or its distance transform, with their respective METRO interactions in the probability models. Two problems with this approach became apparent during initial exploratory regressions, the first econometric and the second, conceptual.

The econometric problem was that the two marine coastal availability measures are highly collinear. This is not surprising. They are both based on the same "raw" uncorrected distance, and, since coastal waters tend to be relatively unpolluted pre-policy, the corrected distances are quite similar. In any case, in order to avoid numerically unstable estimates and the other econometric problems resulting from the collinearity, we dropped DEEPDIST and DEEPDISM from the models that we report.

The second problem involves the local (state and county) freshwater availability measures. As with the Great Lakes and saltwater availability, the pollution measures are available only at the state level. In order to translate these measures into availability as perceived by an individual consumer, one must make the very strong assumption that pollution is evenly distributed, in county terms, along a coast-line or across freshwater bodies within a state. Therefore, although we estimated both probability of participation and intensity of participation models with both state and county-level freshwater availability, only the state-level freshwater availability results are reported here, since we felt that these are based on assumptions about the distribution of pollution that are not quite as heroic as those for the county-level data.

Methodology and Results

For each dependent variable, we estimated three different models (excluding the county freshwater availability models). The ideal estimation method would have been logit or probit, since these are classic discrete dependent variable models. Unfortunately, probit could not be used due to technical constraints on available hardware resources (probit estimation required much more core memory than the maximum allowed by the machine’s operating system). Logit estimation was technically feasible bit was very expensive due to the large number of observations in the dataset and the large number of independent variables in the models; therefore, we attempted it on only one model per dependent variable.

The results from the three models, with independent variables and model type (Logit or OLS) are shown in tables 6-1 to 6-3. The freshwater availability measure for the logit models is STFWDIST (state freshwater

Table 6.1. GLFISH Probability of Participation Results

Variable	Logit Model with STFWDIST			OLS Model with STFWDIST		OLS Model with STFWACRE	
	$\hat{\beta}$	T Value	$\partial P/\partial X$	$\hat{\beta}$	T Value	$\hat{\beta}$	T Value
INTERCEPT	-2.81	-2.79*	-0.0338	0.018	2.02*	0.0143	1.57
METRO	-0.002	-0.636	-0.0106	0.0156	1.04	0.0186	1.23
LNAGE	0.508	3.99*	0.00611	0.00290	3.04*	0.00290	3.04*
METLNAGE	0.0103	0.0608	0.000124	0.00303	2.04*	0.00302	2.04*
LNINC	-0.0972	-1.26	-0.00117	-7.01E-04	-0.823	7.90E-04	-0.831
METLNINC	-0.0477	-0.444	-.000574	-0.00115	-0.827	-0.00114	-0.817
SEX	-2.43	-7.39*	-0.0292	-0.0135	-8.02*	-0.0136	-8.03*
METSEX	-0.137	-0.314	-0.00165	-0.0122	-4.69*	-0.0122	-4.69*
GLDIST	-0.00560	-9.86*	-6.73E-05	-1.67E-05	-8.85*	-1.67E-05	-8.57*
GLDISTM	0.00260	4.05*	3.12E-05	-1.22E-05	-4.15*	-1.22E-05	-4.12*
INSHDIST	7.73E-04	2.55*	9.29E-06	4.62E-06	1.55	4.50E-06	1.40
INSHDISHM	-3.39E-04	-0.716	-4.08E-06	6.86E-06	1.24	6.91E-06	1.25
STFWDIST	-0.0474	-1.77	-5.70E-04	-3.12E-04	-1.51	. . .	. . .
STFWDISM	0.0658	1.90	7.10E-04	2.30E-04	0.640	. . .	. . .
SFTWACRE	. . .	. . .	. . .	. . .	. . .	0.0540	0.706
STFACRM	. . .	. . .	. . .	. . .	. . .	-0.03340	-0.304
HDD	-4.41E-05	-0.563	-5.30E-07	1.90E-06	2.07*	1.17E-06	2.20*
HDDM	1.76E-04	1.59	2.12E-06	1.65E-06	2.02*	1.60E-06	1.96*
R^2 :	N.A.			0.0293		0.0292	
. F Value :				57.401*		57.279*	
Chi-square :	941.78*			N.A.		N.A.	

* denotes significance at 0.05 level.

$\partial P/\partial X$: logit $\hat{\beta}$ * p * (1 - P), where p= sample probability of fishing.

Table 6.2. INSHFISH Probability of Participation Results

Variable	Logit Model with STFWDIST			OLS Model with STFWDIST		OLS Model with STFWACRE	
	$\hat{\beta}$	T Value	$\partial P/\partial X$	$\hat{\beta}$	T Value	$\hat{\beta}$	T Value
INTERCEPT	-3.43	-8.89*	-10.237	0.0172	0.817	-0.0527	-2.51*
METRO	1.42	2.52*	0.098	0.120	3.45'	0.0923	2.65*
LNACE	0.487	9.85*	0.0336	0.0211	9.60*	0.0212	9.61*
METLNAGE	0.640	0.90	0.00441	0.00761	2.22*	0.00704	2.05*
LNINC	0.0529	1.48	0.00365	0.00510	2.58*	0.00517	2.62*
METLNINC	-0.0876	-1.69	-0.00605	-0.0050	-1.55	-0.00454	-1.41
SEX	-1.71	-19.2*	-0.118	-0.0773	-19.8	-0.0774	-19.8*
METSEX	-0.137	11.07	-0.00945	-0.0338	-5.59*	-0.0335	-5.55*
GLDIST	0.00063	8.85*	4.35E-05	5.11E-05	11.7*	5.59E-05	12.4*
GLDISTM	-.000448	-3.99*	3.10E-05	-2.92E-05	-4.31*	-3.26E-05	-4.74*
INSHDIST	-0.00456	-20.1*	-.000315	-.000156	-22.6*	-.000147	-19.9*
INSHDISM	0.00061	1.70	4.22E-05	-1.31E-06	-0.10	-1.33E-05	-1.04
STFWDIST	-0.0552	-4.76*	-0.00381	-0.00415	-8.68*	. . .	. . .
STFWDISM	-0.0193	-1.01	-0.00133	-0.00167	-1.95	. . .	. . .
STFWACRE	. . .	. . .	. . .	. . .	. . .	1.34	7.55
STFWACRM	. . .	. . .	. . .	. . .	. . .	0.384	1.49
HDD	3.15E-06	0.174	2.18E-07	4.41 E-06	3.62*	4.38E-06	3.57*
HDDM	-6.61E-05	-2.49*	-4.56E-06	-8.20E-06	-4.32*	-6.28E-06	-3.33*
R^2 :	N. A.			0.095		0.094	
Chi-square :	3273.4*			N. A.		N. A.	
F-value :				199.3'		199.2	

*Denotes significance at 0.05 level.

$\partial P/\partial X$: logit $\hat{\beta}$ * p * (1 - p) , where p= sample probability of fishing.

Table 6.3. DEEPFISH Probability of Participation Results

Variable	Logit Model with STFWDIST $\hat{\beta}$	Logit Model with STFWDIST T Value	Logit Model with STFWDIST $\partial P/\partial X$	OLS Model with STFWDIST $\hat{\beta}$	OLS Model with STFWDIST T Value	OLS Model with STFWACRE $\hat{\beta}$	OLS Model with STFWACRE T Value
INTERCEPT	-5.29	-7.86*	-0.147	-0.00172	-0.125	-0.0346	-2.52*
METRO	2.76	3.06*	0.0766	0.0848	3.73*	0.0782	3.43*
LNAGE	0.443	5459*	0.0123	0.00762	5.29*	0.00764	5.30*
METLNAGE	0.0749	0.676	0.00208	0100457	2.04*	0.00435	1.94*
LNINC	0.725	3.53*	0.00624	0.00505	3.91*	0.00511	3.96*
METLNINC	-0.263	-3.14*	-0.00731	-0.00500	-2.37*	-0.00485	-2.30*
SEX	-1.84	-11.4*	-0.051	-0.0307	-11.2*	-0.0307	-12.0*
METSEX	-0.295	-1.29	-0.00818	-0.0211	-5.36*	-0.0211	-5.34*
GLDIST	0.000172	1.51	4.76E-06	7.15E-06	2.50*	1.00E-05	3.40*
GLDISTM	-0.000184	-1.09	-5.12E-06	-5.27E-06	-1.19	-7.85E-06	-1.74
INSHDIST	-0.00337	-10.7	-9.35E-05	-4.83E-05	-10.7*	-4.21E-05	-8.68*
INSHDISM	0.000367	0.749	1.02E-05	-1.56E-06	-0.19	-9.66E-06	-1.15
STFWDIST	-0.0791	-3.96*	-0.00227	-0.00178	-5.68*	. . .	. . .
STFWDISM	0.0271	0.947	7.53E-04	-.000663	-1.18	. . .	. . .
STFWACRE	. . .	. . .	. . .	. . .	. . .	0.697	6.02*
STFWACRM	. . .	. . .	. . .	. . .	. . .	-0.0176	-0.104
HDD	-5.82E-05	-2.13*	-1.62E-06	-7.89E-07	-0.99	-1.02E-06	-1.27
HDDM	-9.14E-05	-2.37*	-2.54E-06	-5.34E-06	-4.30*	-4.30E-06	-3.49*
R^2 :	N.A.			N. A.		0.037	
Chi-square :	1197.74*			N. A.		N. A.	
F-value :				72.4*		72.9*	

*Denotes significance at 0.05 level.

$\partial P/\partial X$ = logit $\hat{\beta}$ * p * (1 - p) , where p= sample probability of fishing.

acres/total acres)$^{-0.5}$. For the OLS version we estimated both STFWDIST (shown in the same table as the logit result) and the acres/acre analog, STFWACRE: Each is estimated with its corresponding METRO interaction, STFWDISM and STFWACRM respectively. As noted above, DEEPDIST and its METRO interaction were dropped due to extreme multi-collinearity with INSHDIST and INSHDISM, respectively. The socio-economic variables METRO, LNINC, LNAGE and METLNINC, METLNAGE were quite collinear, with condition indices of 75-80, depending on the freshwater availability measure specified, so the parameter estimates for these variables should be viewed with suspicion. However, the availability measures themselves (GLDIST, INSHDIST, and either STFWDIST or STFWACRE) and their METRO interactions were not contaminated by collinearity to any great degree.

The results generally support the following conclusions. For Great Lakes fishing, (GLFISH), the $\hat{\beta}$ on GLDIST is negative and significant, while the $\hat{\beta}$'s for STFWDIST and STFWACRE, and INSHDIST are positive and insignificant. Apparently, for Great Lakes participation, the only important availability is that for Great Lakes. Freshwater and saltwater availability do not seem to enter into the decision on whether or not to participate. These results are consistent across the OLS and logit estimations. The fact that the parameter estimates for OLS vary only slightly between the STFWDIST and STFWACRE models demonstrates the absence of significant collinearity between the freshwater availability measures and the other variables included in the regressions.

For inshore saltwater fishing (INSHFISH) the results are somewhat more complex, since the $\hat{\beta}$'s on all of the availability measures are significant. The sign on GLDIST is always positive, indicating that the farther one is from the Great Lakes, the more likely one is to do some inshore saltwater fishing, a reasonable result. The sign on INSHDIST is negative, which implies that the farther one is from a saltwater coastline, the less likely one is to be an inshore saltwater fisherman; again a reasonable result. The coefficients on freshwater availability are more puzzling, however. For the logit model and the OLS model with state freshwater distance (STFWDIST), the $\hat{\beta}$'s are negative and significant. This implies that the greater the expected distance to freshwater fishing sites in one's home state, the less likely one is to be an inshore saltwater fisherman. The $\hat{\beta}$ on STFWACRE in the second OLS model is positive and significant, which implies that as the ratio of freshwater area to total land area (a_w/a_t) increases the Probability of doing some inshore saltwater fishing increases. (Note that the STFWDIST and STFWACRE results are consistent with one another, since as (a_w/a_t) increases, expected distance, $(a_w/a_t)^{-0.5}$ decreases). This result contradicts our prior expectation, that as freshwater recreational fishing cost (or its proxy, travel distance) increased, one would be more likely to engage in a substitute activity, such as saltwater fishing.

One possibility, as with any econometric estimation is that some simple peculiarity in the data is causing anomalous results. The fact that the result is robust over 3 models for INSHFISH and 3 models for DEEPFISH (as will be seen below) suggests that this is probably not the case, and the large size of the dataset makes outlier deletion and other observation-by-observation diagnostic techniques impractical. Assuming one accepts the results at face value, how can they be explained? The most straightforward hypothesis is that individuals doing some saltwater fishing also do some freshwater fishing, and perhaps the two activities use similar skills and equipment. Under this hypothesis, an individual would perhaps learn to fish in freshwater, and transfer those skills to saltwater; the net result being that on average, in areas where freshwater recreational fishing opportunities are scarce, a potential saltwater fisherman would have less opportunity to learn the skills required for saltwater fishing. This would lead to the results we obtained.

One method for testing this hypothesis would be to estimate models similar to the GLFISH, INSHFISH, and DEEPFISH models, with mutually exclusive categories that include freshwater fishing as an explicit possible activity. Unfortunately, there would be 15 mutually exclusive categories to be used, and the number of participants in many of the 15 categories would be too small for accurate model estimation. Therefore, these results remain an unexplained anomaly.

The results for offshore saltwater fishing (DEEPFISH) were similar to results for inshore saltwater fishing. The $\hat{\beta}$ on GLDIST was positive and significant for both OLS models, although for the logit model it was positive and insignificant, with a "t" of 1.51. The $\hat{\beta}$ on INSHDIST was negative and significant for all three models, and STFWDIST and STFWACRE had the same problems (positive significant $\hat{\beta}$'s and negative significant $\hat{\beta}$'s, respectively) as was the case for INSHFISH.

The availability-METRO interactions for all of the fishing types and all of the models for each type were nearly always insignificant; the one exception was the three INSHFISH models, where the GLDIST and STFWDIST/STFWACRE interactions were significant. On the basis of these results, one cannot reject the null hypothesis that SMSA residents do not react differently than non-SMSA residents with respect to changes in availability.

INTENSITY MODEL ESTIMATION

The models for estimating intensity of participation in Great Lakes and saltwater fishing closely parallel those used for the probability of participation. The datasets employed are subsets of the probability of participation dataset, containing only participants in the activity of interest, i.e., those respondents who did some Great Lakes, inshore saltwater, or offshore saltwater fishing. As noted in chapter 5, the dependent variables are the natural logs of the number of days an individual participated, LNGTLADA, LNSALTDA, and LNDEEPA, respectively. Means, standard deviations, and definitions were shown in tables 5.2 through 5.7.

The functional form using logs of intensities has one distinct advantage over natural units (i.e., "days" untransformed). This is that the average consumer surplus per day can be calculated directly from the coefficient on travel cost in the estimated equation (Miller, 1984). In the present application, some modification is required, since the models employ travel distance rather than travel cost as an exogenous variable. Given a model of the following form:

$$LN(DAYS) = b_0 + b_1 \text{ (Travel Cost)}$$

the average consumer surplus in dollars per day is simply $-1/b_1$, assuming that b_1 is negative, travel cost is measured in dollars, and that the "DAYS" are single-day trips. Since travel cost equals 2 times the one-way distance times cost per unit distance, the appropriate consumer surplus from the model assuming a travel cost of 10¢/mile is

$$\overline{CS} = \frac{-1}{b_D} * 2 * \$0.10/\text{mile}$$

where b_D is the parameter on distance, and $\overline{CS}$ is average consumer surplus in dollars per person per day. This produces an easily calculated measure of average consumer surplus per day, providing the assumption about each fishing day being a single-day trip is met.

The disadvantage of this method is that it is tricky to project changes in intensity of participation post-policy, since the dependent variable in each model is a non-linear transformation of the variable that is directly of interest, namely days of fishing participation. (This issue is discussed in detail in chapter 11 on boating intensity. Of the three methods there employed for calculating changes in boating intensity, we have used only the "ratio" method for this application, as it seems to be most effective at removing re-transformation bias.)

As with the intensity of participation estimation for boating, the models of intensity for fishing are estimated using both unweighted OLS and the Tukey biweight methods. (See chapter 11.) This was done to correct for possible outliers in the datasets; in particular, individuals reporting very high participation intensities, in excess of 100 days per year. As will be seen in the results section, the two methods produce very similar results for each fishing type, suggesting that outliers do not have any noticeable effect on the models of interest.

Three changes from our original plan for estimation were made for the intensity estimation. First, as noted in the chapter on database formation, we had planned to estimate intensity models for "all positive" observations and for “positives” residing with 250 miles of the coast (i.e., GLDIST ≤ 250 for Great Lakes fishing, and INSHDIST ≤ 250 for saltwater fishing). Although both sets of positives were used, we only report the results for the individuals living within 250 miles. This is done for two reasons. The first is that in order to obtain theoretically correct results for the consumer surplus calculations, one must assume that there is an easily specified correspondence between travel distance and travel cost. For the cost-distance relationship to hold, the most reasonable assumption is that a day's participation involves a round-trip between the participant's home and the recreational site. This assumption clearly becomes less reasonable for participants living more than one day's drive from the recreation site. The second and related reason is that the $\hat{\beta}$'s on travel distance were frequently positive and significant for the "all positives" models. Examination of the data revealed that some respondents living hundreds of miles from the coast reported 10-20 days of coastal fishing. They were apparently vacationers taking multi-day trips, and so could not be explained by a model assuming a one-to-one relationship between "trips" and "days".

The second change was that the METRO*availability interaction terms produced extreme multicollinearity within the intensity datasets, making accurate estimation of the interaction parameters impossible. It was therefore necessary to drop the interaction terms from the models reported. Recall that these interaction terms were generally statistically insignificant in the probability of participation models, so it is doubtful that this deletion had a deleterious effect on the predictive accuracy of the models. This multicollinearity apparently occurred because of reduced sample sizes in the datasets used for the intensity estimation.

The final change, already noted in the database formation chapter, was the deletion of DEEPDIST, because of collinearity problems, and the county freshwater availability models, due to the very strong assumptions involved in interpreting the potential results. As with the probability of participation models, the county-level availability equations were actually estimated but are not reported here.

This results in a total of twelve models reported in the results section: They are:

LNGTLADA or LNSALTDA or LNDEEPA	*	STFWDIST OF STFWACRE	*	OLS or Tukey

The details of the results are shown in the next section.

Results

Estimation results are shown in tables 6.4 through 6.6. The results for Great Lakes intensity are essentially inconclusive, since the "F" statistics for both the STFWDIST and STFWACRE models are not significantly different from zero. This is undoubtedly due, at least in part, to the small sample size (291 observations). The only significant coefficients are those for INSHDIST and HDD, and although these results are consistent across models, the lack of a significant “F” statistic implies that the overall regressions are purely chance results.

In contrast, the inshore and offshore saltwater fishing results are significant, in terms of both overall "F" statistics and the coefficients on the availability measures. Generally, the STFWACRE models seem to be somewhat better predictors of intensity than the STFWDIST models, using the informal criterion of R^2 or “F” statistic comparison. As with the probability of participation models, the $\hat{\beta}$'s on GLDIST are positive and significant, and the $\hat{\beta}$'s for INSHDIST are negative and significant. In addition, the $\hat{\beta}$'s for STFWDIST are always negative and significant, while those for STFWACRE are always positive and significant. (Note that the

Table 6.4. Intensity of Great Lakes Fishing Estimation Results[a]

Variable	STFWDIST Results				STFWACRE Results			
	OLS $\hat{\beta}$	OLS "T"	Tukey $\hat{\beta}$	Tukey S.E.	OLS $\hat{\beta}$	OLS "T"	Tukey $\hat{\beta}$	Tukey S.E.
INTERCEPT	-1.91	-1.38	-2.54	1.29	-0.792	-0.63	-1.42	1.14
METRO	0.970	0.609	0.950	1.44	1.13	0.70	1.10	1.46
LNAGE	0.362	1.42	0.436	0.23	0.351	1.38	0.410	0.23
METLNAGE	0.154	0.429	0.153	0.32	0.161	0.45	0.164	0.33
LNINC	0.0500	0.553	0.0424	0.08	0.0500	0.64	0.0542	0.08
METLNINC	-.053	-0.407	0.0047	0.12	-0.0592	-0.45	-0.0106	0.12
SEX	0.193	0.449	0.218	0.39	0.206	0.48	0.225	0.40
METSEX	0.085	0.157	0.102	0.99	0.134	0.247	0.156	0.50
CLDIST	-0.00147	-1.16	-0.00128	0.001	-0.001	-0.86	-0.00077	0.001
INSHDIST	-0.0011	-2.95*	-0.0013	0.004*	-0.001	-2.35*	-0.001	0.00003*
STFWDIST	0.050	1.28	0.052	0.035	...	...	...	...
STFWACRE	...	...	...	...	3.09	0.28	-1.38	10.2
HDD	0.0003	2.16*	0.0004	0.0001*	0.00018	1.11	0.00027	0.0001
HDDM	-0.0001	-0.974	-0.0002	0.0001	-0.00015	-1.08	-0.00023	0.0001
PREF	-0.0016	-0.007	0.051	0.20	0.0088	0.04	0.051	0.20
METPREF	-0.122	-0.412	-0.137	0.27	-0.157	-0.53	-0.166	0.27
R^2	0.071		NA		0.066		NA	
F-value	1.51				1.39			
Consumer surplus[b]	136		156		190		260	

*Denotes significance at 0.05 level.

Number of observations: 291

Notes:

a) Includes only participants with GLDIST 6 250 miles, pre-policy.

b) Consumer surplus = $-2/\hat{\beta}_{GLDIST}$ *0.10 (in dollars/person/day). See text for derivation of formula.

Table 6.5. Intensity of Inshore Saltwater Fishing Estimation Results[a]

Variable	STFWDIST RESULTS				STFWACRE RESULTS			
	OLS $\hat{\beta}$	OLS "T"	Tukey $\hat{\beta}$	Tukey S.E.	OLS $\hat{\beta}$	OLS "T"	Tukey $\hat{\beta}$	Tukey S.E.
INTERCEPT	1.14	1.96*	1.01	0.36*	0.571	1.45	0.418	0.37
METRO	0.557	1.04	0.674	0.50	0.494	0.93	0.611	0.50
LNAGE	0.318	3.59*	0.323	0.08*	0.319	3.61*	0.325	0.08*
METLNAGE	-0.187	-1.41	-0.159	0.12	-0.199	-1.51	-0.179	0.124
LNINC	-0.0042	-0.12	0.0043	0.03	0.0007	0.02	0.0089	0.034
METLNINC	0.0016	0.03	-0.020	0.05	0.0004	0.05	-0.0194	0.048
SEX	-0.187	-1.73	-0.208	0.10	-0.189	-1.76	-0.211	0.10
METSEX	-0.0178	-0.12	0.0098	0.14	-0.0165	-0.11	0.0103	0.143
GLDIST	0.00011	1.81	0.00013	5.7E-05*	0.00016	2.63*	0.00017	5.7E-05*
INSHDIST	-0.00480	-8.44*	-0.00482	0.00005*	-0.00422	-8.06*	-0.00444	0.0005*
STFWDIST	-0.0244	-2.22*	-0.0268	0.01*	...	...	...	...
STFWDIST	...	...	...	...	10.13	4.33*	10.63	2.20*
HDD	-0.00003	-1.38	-0.00003	1.9E-05	-0.00002	-1.12	-0.00002	1.9E-05
HDDM	-6.99E-06	-0.24	-1.0E-05	2.7E-05	0.00002	0.62	0.00002	2.8E-05*
PREF	0.141	1.83	0.162	0.072*	0.143	1.86	0.161	0.072*
METPREF	0.007	0.06	0.003	0.104	0.005	0.05	-0.0003	0.10
R^2	0.080		N.A.		0.871		N.A.	
F-value	12.92*				14.00*			
Consumer surplus[b]	41.7		41.4		45.2		45.0	

“Denotes significance at 0.05 level.

Nuber of observations: 1908

Notes:

a) Includes only participants with INSHDIST ≤ 250 miles, pre-policy.

b) Consumer surplus = $-2/\hat{\beta}_{INSHDIST}$ *0.10 (in dollars/person/day). See text for derivation of formula.

Table 6.6. Intensity of Offshore Saltwater Fishing Estimation Results[a]

Variable	STFWDIST RESULTS				STFWACRE RESULTS			
	OLS $\hat{\beta}$	OLS "T"	Tukey $\hat{\beta}$	Tukey S.E.	OLS $\hat{\beta}$	OLS "T"	Tukey	Tukey S.E.
INTERCEPT	0.117	0.19	-0.124	0.55	-0.708	-1.08	-0.740	0.58
METRO	1.02	1.20	0.814	0.75	0.978	1.17	0.738	0.74
LNAGE	0.464	3.23*	0.474	0.13*	0.444	3.13*	0.457	0.13*
METLNAGE	-0.302	-1.47	-0.0976	0.18	-0.282	-1.39	-0.0964	0.18
LNINC	-0.0015	-0.03	-0.0013	0.05	0.0040	0.07	-0.00184	0.05
METLNINC	-0.0198	-0.26	-0.0691	0.07	-0.0294	-0.38	-0.0673	0.07
SEX	0.0332	0.18	0.0357	0.17	0.050	-0.06	0.0169	0.17
METSEX	0.0175	0.07	0.0390	0.23	-0.0146	-0.06	0.0169	0.23
GLDIST	0.000049	0.52	0.000041	8.4E-05	0.000119	1.23	9.9E-05	8.6E-05
INSHDIST	-0.00300	-3.87*	-0.00270	6.8E-05*	-0.00256	-3.36*	-0.00239	6.7E-05*
STFWDIST	0.0438	-2.54*	-0.0368	0.016*	...	...	...	...
STFWACRE	...	...	...	...	13.54	4.01*	11.48	3.03*
HDD	-7.6E-05	-2.58*	-5.7E-05	2.6E-05*	-5.8E-05	-1.93	-4.6E-05	1.6E-05
HDDM	5.1E-05	1.24	3.66-05	3.7E-05	7.4E-05	1.79	5.7E-05	3.7E-05
PREF	-0.0325	-0.28	-0.0556	0.10	-0.0239	-0.20	-0.042	0.10
METPREF	0.192	1.18	0.215	0.14	0.155	0.96	0.177	0.14
R^2	0.078		N.A.		0.091		N.A.	
F-value	5.24*				5.99*			
Consumer surplus[b]	66.7		74.2		78.0		83.6	

*Denotes significant at 0.05 level.

Number of observations:

a) Includes only participants with INSHDIST ≤ 250 miles, pre-policy.

b) Consumer surplus = $-2/\hat{\beta}_{INSHDIST}$ * 0.10 (in dollars/person/day). See text for derivation of formula.

results are consistent with each other.) As is generally the case the recreation participation models, the R^2'S are fairly low, ranging from 0.0078 to 0.091. The estimation method (OLS versus Tukey biweight) does not have much effect on the significant estimated parameters.

CONCLUDING COMMENTS

Since we faced problems in both the participation and water quality (or availability) sides, it is not especially shocking to find disturbing results at the estimation stage. The fact that fresh and saltwater fishing appear to be complementary rather than substitute activities gives us sane pause but need not discourage us. As we shall see in the next chapter a much more serious problem turns on the relation between saltwater and Great Lakes fishing, which is of the expected sign in these equations.

NOTES

1. Models in which only availability net of pollution restrictions is included are termed "environmentalist" models in the discussion below in chapter 10. This nomenclature reflects the propensity for producing positive benefit numbers. This, in turn, follows from the twin likelihoods that:

- participation will be positively related to gross availability
- gross and net availability will not on average be very different because pollution restrictions involve small fractions of the total water area of each state or county.

REFERENCES

Miller, Don M. 1984. "Reducing Transformation Bias in Curve Fitting," American Statistician, vol. 58, no. 2 (May), pp. 124-126.

Chapter 7

GREAT LAKES AND SALTWATER RECREATIONAL FISHING: BENEFIT ESTIMATION

This chapter begins with a discussion of the prediction of changes in participation probabilities and intensities attributable to a pollution control policy that leads to increased availability of the relevant resources. In all cases the assumed policy is the one described to respondents in Dyson’s state survey. (Appendix 5.C). This policy consists of a combination of Best Available Technology (BAT) applied to point sources of toxics pollutants, Best Conventional Technology (BCT) applied to point sources of conventional pollutants, and Best Management Practices (BMP) applied to nonpoint sources of pollution such as agricultural and urban runoff. Changes in participation are valued using average willingness to pay for a day’s activity as reported elsewhere. We also produce and use a value based on parameter estimates from this study itself.

It is demonstrated that assumptions about the extent of coverage of this policy can have dramatic effects on the estimated changes. Indeed, because of the peculiar nature of some of our water quality data, the difference between a limited policy and one covering all potential resource areas (fresh, Great Lakes, and saltwater) can be the difference between a positive and a negative “benefit” for particular categories of activity.

PREDICTING CHANGES IN THE PROBABILITY OF PARTICIPATION

If the sample used for estimating the probability of participation had been balanced, it would have been straightforward to predict the change in probability due to the assumed policy. The method used would have been to calculate the change in each respondent's availability measures, and substitute these into the estimated equation results to derive post-policy participation probabilities. However, because the sample was seriously skewed, with too many non-metro residents and disproportionate state-by-state representation, this method had to be modified, to produce a vector of mean values of the independent variables that could be said to be representative of an average resident of the U.S.

This method of evaluating the changes in participation post-policy rests on three important assumptions, closely paralleling those used in the estimation. The first is that the vectors of $\hat{\beta}$'s estimated for the sample are indeed representative of those for an average U.S. citizen. This means that there are assumed to be no regional or state-by-state differences in the probability of participation that are not captured in the models. The second assumption is that there are no systematic differences between metro and non-metro residents other than those captured by METRO and the metro interaction terms in the models. The third assumption is that clean-up of all water - Great Lakes, saltwater, and freshwater (non-Great Lakes) takes place simultaneously, and that both BAT, BCT, and BMP are all implemented. Obviously, these are all strong assumptions.

The problem of creating a representative vector of means for evaluation can be divided into two parts--the availability measures and the socio-economic variables. Recall from chapter 5, appendix 5.B, that the availability measures were originally calculated on a county level. This made it straightforward to recalculate them, using county population over 9 years of age (for consistency with the mail survey) as a weight in producing national means. These values, shown in table 7.1, were used in

Table 7.1. Means Used for Evaluation of Probability of Participation Equations

	Variable	Mean
SOCIO-ECONOMIC:	METRO	0.727
	LNAGE	3.210
	METLNAGE	2.33
	LNINC	9.321
	METLNINC	6.82
	SEX	0.454
	METSEX	0.335
	HDD	6508.
	HDDM	4677.
AVAILABILITY:		
	GLDIST	701.7
	GLDISTPO	538.3
	GLDISTM	539.7
	GLDISTPM	403.0
	INSHDIST	249.0
	INSHDIPO	248.9
	INSHDISM	157.4
	INSHDIPM	157.3
	STFWDIST	8.05
	STFWDIPO	7.65
	STFWDISM	5.82
	STFWDIPM	5.566
	STFWACRE	0.0209
	STFWACPO	0.0223
	STFWACRM	0.0152
	STFWACPM	0.0162

Definitions of variables not previous referenced:

Variable name	Definition
GLDISTPM	GLDISTPO*METRO
INSHDIPM	INSHDIPO*METRO
STFWDIPM	STFWDIPO*METRO
STFWACPM	STFWACPO*METRO

the subsequent evaluation, and taken to be population-weighted averages representative of an average U.S resident.

The means of the socio-economic variables were calculated somewhat differently. Because the precise within-state sampling method used in the original surveys could not be determined, we stratified the data used in the participation survey into metro and non-metro residents, and calculated the means of LNAGE, LNINC, etc., for each group. This gave a pair of means vectors, one for metro residents and the other for non-metro residents. These were assumed to be representative of “average” metro and non-metro residents for the U.S. population, respectively. Then, using as weights the number of metro and non-metro residents greater than 9 years of age, respectively we calculated a single vector of weighted means for the socio-economic variables used in the estimation. These results are also shown in table 7.1. In principle, more accurate results could have been obtained using Census data by county. However, obtaining income data consistent with the information in the participation sample would have been very difficult. In addition, since we employed non-linear transformations of age and income in estimation, computing measures of these transformations (LNINC and LNAGE) from aggregate data would have been problematic. Given these problems, and the fact that the method actually used for calculating the weighted socio-economic means is consistent with the assumptions employed in the estimation procedure, the simpler method using participation data directly was preferred.

The results of evaluating the participation probability equations at the means pre-policy and post-policy are shown in table 7.2. Each column refers to a specific dependent variable. The first row shows the actual probabilities from the sample used in estimation. The next line is the

Table 7.2. Evaluation of Changes in Probability of Participation

	Dependent Variables		
	GLFISH	INSHFISH	DEEPFISH
Actual Sample Probability	0.012	0.075	0.028
OLS Models: Probabilities based on STFWDIST			
Pre-policy	0.016	0.087	0.035
Post-policy	0.020	0.085	0.035
Change	0.004	-0.002	0.000
OLS Models: Probabilities based on STFWACRE			
Pre-policy	0.016	0.087	0.035
Post-policy	0.020	0.084	0.035
Change	0.004	-0.003	0.000
Logit Model: Probabilities based on STFWDIST			
Pre-policy	0.002	0.038	0.014
Post-policy	0.004	0.037	0.014
Change	0.002	-0.001	0.000

result of multiplying the OLS STFWDIST $\hat{\beta}$ vector by the weighted pre-policy means of the independent variables. For each dependent variable, this predicted pre-policy mean is about 15-20 percent higher than the actual sample mean. This results from the somewhat higher values for METRO and the METRO interaction terms in the vector of weighted means compared to the actual sample means. The next line shows the predicted probabilities post-policy, using the same socio-economic weighted means as the pre-policy prediction but with post-policy weighted means for the availability variables. The fourth line is simply the post-policy predicted probability minus the pre-policy predicted probability. The entries for the OLS STFWACRE models are analogous to the STFWDIST entries.

The logit model entries are similarly arranged. The formula for computing the predicted probabilities is:

$$\frac{1}{1 + \exp\left[-\left(\sum_{i=1}^{n} \hat{\beta}_i \bar{X}_i\right)\right]}$$

where the $\hat{\beta}$'s are the coefficients from the logit model including the intercept and the $\bar{X}$'s are the weighted means (including a constant term as $\bar{X}_1$) shown in table 7.1.

Three aspects of the results are especially interesting. The first is that the predicted pre-policy logit probabilities are roughly 15-50 percent of the actual sample probabilities, pre-policy. This cannot be accounted for by the use of weighted means, since the use of actual sample means produces similar results. The results are instead due to using the means of the independent variables in the logit predictions, instead of predicting the probabilities observation-by-observation and taking the mean of the observation-wise probabilities. Since the predicted probabilities are calculated by non-linear transformations of the independent variables, the two methods will not, in general, give the same results. The observation-by-observation method was not used in this case, because of the unbalanced sample problem.

The second interesting result is that the predicted change in the probability of doing some offshore saltwater fishing (DEEPFISH) is approximately zero. This occurs because the Great Lakes distances change by 23 percent to 25 percent, while the other availability measures change only slightly, post-policy.

The final interesting aspect of the results is that the predicted probability of doing some inshore saltwater fishing (INSHFISH) actually decreases post-policy for much the same reason. This means that as more fishable water in all three classes (saltwater, Great Lakes, and freshwater) becomes available, our models predict a decline in inshore saltwater fishing participation. This result is counter-intuitive. To see more clearly how it was produced, consider the INSHFISH OLS STFWDIST model parameters shown in table 7.3. The last column of the table shows each parameter’s contribution to the overall change in the probability of doing some inshore saltwater fishing. As is evident in the table, the large changes in the weighted means of GLDIST and GLDISTM, pre- to post-policy, result in their overwhelming the effects of the other availability parameters vis a vis the predicted change in probability. Their effects on the predicted probability post-policy are at least an order of magnitude larger than those of the other parameters, INSHDIST, STFWDIST, and their METRO interactions. Adding the net effect of GLDIST (-0.00835) and the effect of GLDISTM (0.00400), shown in the last column of table 7.6, results in a change in the predicted probability of -0.00435, which overwhelms the

Table 7.3. Detailed Examination of the OLS Probability Equations for Inshore Saltwater Fishing

Variable Name	OLS $\hat{\beta}$[a]	Pre-Policy[b] Weighted Mean	Post-Policy[c] Weighted Mean	Post-Policy $\bar{X}$ - Pre-Policy $\bar{X}$[d]	Partial Change in Predicted Probability[e]
GLDIST	0.0000511	701.7	538.3	-163.4	-0.00835
GLDISTM	-0.0000292	539.7	403.0	-136.7	0.00400
INSHDIST	-0.000156	249.0	248.9	-0.10	0.000016
INSHDISM	-0.0000013	157.4	157.3	-0.10	0.00000001
STFWDIST	-0.00415	8.05	7.65	-0.40	0.0016
STFWDISM	-0.00167	5.82	5.56	-0.26	0.000423
					≈-0.0022

Footnotes:

a) OLS $\hat{\beta}$ from column 5 of table 6.2.

b) Pre-policy weighted means are from table 7.1.

c) Post-policy weighted means are post-policy values (GLDISTPO, GLDISTPM, INSHDIPO, INSHDIPM, STFWDIPO, STFWDIPM) from table 7-1.

d) Post-policy weighted mean - pre-policy weighted mean.

e) OLS $(\hat{\beta})$ * (Post-policy $\bar{X}$ - Pre-policy $\bar{X}$).

net contributions of the other parameters. The change in GLDIST is about 23% and that for GLDISTM about 25%. If these had been about 10% each, the total net change in probability would have been small but positive. Similar results can be derived for the INSHFISH Logit model and the INSHFISH OLS STFWDIST models.

These results should not be interpreted as a contradiction of economic theory, nor should they be taken as an indication that participation in inshore saltwater fishing will decline after full implementation of the Clean Water Act. Rather, we are inclined to believe they illustrate the problems of attempting to measure the benefits of cleaner water without an adequate database of water quality parameters prior to policy implementation or a suitable means of predicting the policy induced change in availability. Regardless of the econometric techniques applied to this combination of recreation participation surveys and "water quality" parameters derived from the collective wisdom of knowledgable state officials, the fundamental lack of environmental data derived from actual ambient quality monitoring programs must make us suspicious of the results.

PROJECTING CHANGES IN INTENSITY OF PARTICIPATION

The three datasets used for estimating the intensity of participation models have the same sample balance problems as those used for the probability of participation models, since the former are subsets of the latter. Therefore, a similar approach was employed to produce balanced weighted vectors of means for projecting changes in intensity post-policy. The only difference is that instead of creating vectors of means for the entire U.S., we created such vectors for two different populations -- one for a population with GLDIST $\leq$ 250 miles pre-policy, for the Great Lakes intensity evaluation, and a second for a population with INSHDIST $\leq$ 250 miles pre-policy, for the inshore and offshore saltwater intensity evaluations. Except for these different base populations involved, the methods used were the same as those for the probability of participation evaluation means. Values for these vectors are shown in table 7.4.

The method used to predict changes in intensity of participation post-policy is the "ratio" method, developed for the boating intensity evaluation, and explained in chapter 11 below. This method has some advantages over other potentially useful evaluation procedures. Table 7.5 shows the results of the evaluation for each model. Note that for each model type the pre-policy means are weighted for evaluation to account for the sample balance problem, which explains the difference between the actual sample means (shown in the first line of the table) and the "pre-policy" means for each model. As with the probability of participation models, projected changes are small relative to the pre-policy means, and are frequently negative, with post-policy values smaller than pre-policy values. As with the probability of participation evaluation, this is usually due to the large change in GLDIST swamping the other availability measure changes. The one particularly curious feature about the results in that projected changes in Great Lakes intensity are either negative or, in the Tukey STFWACRE model, zero. This occurs because the difference in GLDIST pre- versus post-policy is very small (about 3.4 miles), and $\hat{\beta}_{GLDIST}$ for the Great Lakes models is also small (-0.00147 to -0.00077), while the change in the state freshwater availability measures area quite large, as are the relevant $\hat{\beta}$'s. The partial effect of State freshwater changes therefore overwhelms that of Great Lakes availability.

Table 7.4. Pre-Policy and Post-policy Weighted Means of Independent Variables used in Evaluation of Intensity of Participation Models

	Great Lakes		Inshore Saltwater		Offshore Saltwater	
	Pre-policy	Post-policy	Pre-policy	Post-policy	Pre-policy	Post-policy
Variable	Mean	Mean	Mean	Mean	Mean	Mean
METRO	0.742	0.742	0.776	0.776	0.776	0.776
LNAGE	3.47	3.47	3.48	3.48	3.49	3.49
METLNAGE	2.57	2.57	2.70	2.70	2.71	2.71
LNINC	9.28	9.28	9.35	9.35	9.39	9.39
METLNINC	6.93	6.93	7.28	7.28	7.30	7.30
SEX	0.0746	0.0746	0.146	0.146	0.102	0.102
METSEX	0.0582	0.0582	0.113	0.113	0.0774	0.017
GLDIST	88.5	85.1	979.4	686.4	929.4	686.4
INSHDIST	447.7	447.6	60.3	60.2	60.3	60.2
STFWACRE	8.33	7.75	7.73	7.23	7.73	7.23
STFWACRE	0.0203	0.0220	0.0226	0.0241	0.0226	0.0241
HDD	6834	6834	4413	4413	4124	4124
HDDM	5027	5027	3334	3334	3056	3056
PREF	0.588	0.588	0.626	0.626	0.620	0.620
METPREF	0.483	0.483	0.503	0.503	0.504	0.504

Table 7.5. Evaluation of Changes in Intensity of Participation[a]

	Great Lakes	Inshore Saltwater	Offshore Saltwater
Actual sample mean intensity	10.6	13.7	6.3
STFWDIST models:			
OLS model pre-policy[b]	10.8	12.8	6.0
OLS model post-policy	10.6	12.6	6.1
OLS model changed	-0.2	-0.2	0.1
Tukey model pre-policy[b]	10.8	12.8	6.0
Tukey model post-policy[c]	10.6	12.5	6.1
Tukey model changed	-0.2	-0.3	0.1
STFWACRE models			
OLS model pre-policy[b]	10.8	12.8	6.0
OLS model post-policy[c]	10.9	12.4	5.9
OLS model change[d]	0.1	-0.4	-0.1
Tukey model pre-policy[b]	10.8	12.8	6.0
Tukey model post-policy[c]	10.8	12.9	5.9
Tukey model change[d]	-0.0	-0.4	-0.1

Notes:

a) Assumes all water cleaned up simultaneously to post BAT, BCT, and BMP levels.

b) Pre-policy values = mean value for participants after correcting metro/non-metro balance. (See text).

c) Predicted intensity post-policy.

d) Change = post-policy prediction-pre-policy value. (See text).

BENEFIT ESTIMATION

The ultimate objective of this exercise is estimation of the benefits from an improvement in water quality attributable to pollution control policy. Such estimates are shown below under two different broad scenarios. The first assumes, as have all equation evaluations to this point, that all water quality is simultaneously improved as much as possible. In this scenario, we ignore the effect of all quality changes on freshwater recreational fishing. The differences in benefits that are derived under this first scenario come solely from two sources--estimation methods, and, as will be seen below, differing methods for calculating average consumer surplus.

The second scenario takes a very different approach. It assumes, as was done with the 1982 freshwater fishing study (Vaughan and Russell, 1982), that only the water bodies used for each respective type of fishing are cleaned up post-policy when evaluating the benefits for a particular fishing type. That is, for deriving Great Lakes fishing benefits, it assumes that <u>only</u> Great Lakes water quality improves post-policy; that for saltwater fishing benefits, <u>only</u> saltwater quality improves, and so forth. The second scenario is carried out to provide a parallel with the earlier work on freshwater fishing, where just this sort of assumption was made with respect to water quality improvement.

Under the simultaneous cleanup scenario, two different sources are used for average consumer surplus. The first is that derived from the $\hat{\beta}$'s on travel distance, estimated in the intensity of participation models. These “internal” values for average consumer surplus are shown in the seventh column (labelled $\overline{CS}$) of table 7.6 - 7.8. They were calculated as shown in the intensity estimation section of chapter 6:

Table 7.6. Total Benefits from Great Lakes Fishing

Probability Estimation Method[a]	$\hat{P}$ Pre-policy[b]	ΔP[c]	Intensity Estimation Method[d]	$\bar{Q}$ Pre-policy[e]	ΔQ[f]	CS[g]	Total Benefits[h]
OLS, STFWDIST	0.016	0.004	Tukey	10.8	-0.2	EST:156	1,098
						LIT:21	148
			OLS	10.8	-0.2	EST:136	957
						LIT:21	148
OLS, STFWACRE	0.016	0.004	Tukey	10.8	0	EST:260	1,967
						LIT:21	159
			OLS	10.8	0.1	EST:190	1,498
						LIT:21	165
Logit, STFWDIST	0.002	0.002	Tukey	10.8	-0.2	EST:136	582
						LIT:21	78
			OLS	10.8	-0.2	EST:136	507
						LIT:21	78

a) From chapter 6.

b) Pre-policy estimate, correcting for sample balance problems.

c) Post-policy predicted mean probability minus pre-policy estimated mean probability.

d) Either Tukey bi-weight or OLS intensity estimation; chapter 6.

e) Estimated pre-policy mean intensity of participation given that an individual participates, after correcting for sample balance problems.

f) Post-policy intensity minus pre-policy intensity, days/participant/year.

g) Average consumer surplus; "LIT" denotes values from Charbonneau and Hay (1978), "EST" denotes values derived from estimated intensity equations, dollars/participant/day.

h) $(\Delta P * \bar{Q} + \Delta Q * \hat{P}) * \overline{CS} * 176{,}000{,}000$; in 10^6 dollars/year.

Table 7.7. Total Benefits from Inshore Saltwater Fishing

Probability Estimation Method[a]	$\hat{P}$ Pre-policy[b]	ΔP[c]	Intensity Estimation Method[d]	$\bar{Q}$ Pre-policy[e]	ΔQ[f]	$\overline{CS}$[g]	Total Benefits[h]
OLS, STFWDIST	0.087	-0.002	Tukey	12.8	-0.3	EST:41	-373
						LIT:22	-200
			OLS	12.8	-0.2	EST:42	-318
						LIT:22	-167
OLS, STFWACRE	0.087	-0.003	Tukey	12.8	-0.4	EST:45	-3,060
						LIT:22	-1,496
			OLS	12.8	-0.4	EST:45	-3,060
						LIT:22	-1,496
Logit, STFWDIST	0.038	-0.001	Tukey	12.8	-0.3	EST:41	-175
						LIT:22	-94
			OLS	12.8	-0.2	EST:42	-151
						LIT:22	-79

a) From chapter 6.

b) Pre-policy estimate, correcting for sample balance problems.

c) Post-policy predicted mean probability minus pre-policy estimated mean probability.

d) Either Tukey bi-weight or OLS intensity estimation; chapter 6.

e) Estimated pre-policy mean intensity of participation given that an individual participates, after correcting for sample balance problems.

f) Post-policy intensity minus pre-policy intensity, days/participant/year.

g) Average consumer surplus, "LIT" denotes values from Charbonneau and Hay (1978), **EST** denotes values derived from estimated intensity equations, dollars/participant/day.

h) $(\Delta P * \bar{Q} + \Delta Q * \hat{P}) * \overline{CS} * 176{,}000{,}000$; in 10^6 dollars/year.

Table 7.8. Total Benefit from Offshore Saltwater Fishing

Probability Estimation Method[a]	$\hat{P}$ Pre-policy[b]	ΔP[c]	Intensity Estimation Method[d]	$\bar{Q}$ Pre-policy[e]	ΔQ[f]	$\overline{CS}$[g]	Total Benefits[h]
OLS, STFWDIST	0.035	0	Tukey	6.0	0.1	EST:74	46
						LIT:73	45
			OLS	6.0	0.1	EST:67	42
						LIT:73	45
OLS, STFWACRE	0.035		Tukey	6.0	-0.1	EST:84	-52
						LIT:73	-45
			OLS	6.0	-0.1	EST:78	-48
						LIT:73	-45
Logit, STFWDIST	0.0114	0	Tukey	6.0	0.1	EST:74	18
						LIT:73	18
			OLS	6.0	0.1	EST:67	16
						LIT:73	18

a) From chapter 6.

b) Pre-policy estimate, correcting for sample balance problems.

c) Post-policy predicted mean probability minus pre-policy estimated mean probability.

d) Either Tukey bi-weight or OLS intensity estimation; chapter 6.

e) Estimated pre-policy mean intensity of participation given that an individual participates, after correcting for sample balance problems.

f) Post-policy intensity minus pre-policy intensity. days/participant/year.

g) Average consumer surplus, "LIT" denotes values from Charbonneau and Hay (1978), "EST" denotes values derived from estimated intensity equations, dollars/participant/day.

h) $(\Delta P * Q + \Delta Q * \hat{P}) * \overline{CS} * 176{,}000{,}000$; in 10^6 dollars/year.

$$\overline{CS} = \frac{-1}{\beta_D} * 2 * \$0.10/\text{mile}$$

where β_D is the estimated coefficient on the relevant distance (GLDIST for Great Lakes, INSHDIST for marine fishing). We assume a travel cost of 0¢/mile. The second source is Charbonneau and Hay (1978), denoted as "LIT" values in tables 7.6 - 7.9, where the benefits are evaluated. Charbonneau and Hay's values were derived using a direct willingness to pay method, for individuals who responded to a question in the 1975 NSHFWR survey concerning their willingness to pay for continuing their favorite wildlife recreational activity. For Great Lakes fishing, we use their value ($21/day) for trout and landlocked salmon, since they did not calculate an average surplus for Great Lakes fishing per se. Their value for general saltwater fishing ($22/day) is employed here for inshore saltwater fishing, and their value of $73/day for offshore saltwater fishing is used for calculating benefits for our offshore category.

The results by fishing category are shown in table 7.6 - 7.8, and an overall summation is shown in table 7.9. Each of the four tables contains a total of twelve total benefits estimates:

3 probability estimates * 2 intensity estimates * 2 $\overline{CS}$ measures.

The results have several interesting features. The first is the large proportion of negative benefits estimates. This occurs because of both negative (or zero) predicted changes in probability of participation and of negative changes in intensity of participation attributable to the policy. For inshore saltwater fishing, the projected benefits are always negative, while for offshore saltwater fishing, all the STFWACRE totals are negative. A second interesting feature is the generally modest size of the results that are positive. The exceptions to this rule are the Great Lakes

Table 7.9. Total Benefits Combining Great Lakes, Inshore Saltwater Fishing, and Offshore Saltwater Fishing

Probability of Participation Estimation Method	Intensity Estimation Method	$\overline{CS}$ Source	Great Lakes	Inshore Saltwater Total	Offshore Saltwater Total	Grand Total
OLS, STFWDIST	Tukey	Estimated	1098	-373	46	771
		Lit	148	-200	45	-7
	OLS	Estimated	957	-318	42	681
		Lit	148	-167	45	26
OLS, STFWACRE	Tukey	Estimated	1977	-3,060	-52	-1135
		Lit	159	-1496	-45	-1382
	OLS	Estimated	1498	-3060	-48	-1610
		Lit	165	-1496	-45	-1376
Logit, STFWDIST	Tukey	Estimated	582	-175	18	425
		Lit	78	-94	18	2
	OLS	Estimated	507	-151	16	372
		Lit	78	-79	18	17

results using average consumer surpluses based on the estimated $\hat{\beta}_{GLDIST}$ values for the intensity of participation models. However, given the poor performance of those models, (using the F-value criterion), and the fact that our derived $\overline{CS}$ values for Great Lakes fishing are about 6.5 to 12 times higher than those derived by Charbonneau and Hay, the total benefits based on the intensity model $\hat{\beta}$'s should probably be disregarded.

Setting aside those values, the projected total consumer surpluses by fishing type range from a high of 165 million dollars per year (Great Lakes, STFWACRE OLS probability and OLS intensity) to a low of -3.06 billion dollars per year (inshore saltwater fishing, STFWACRE OLS probability, both Tukey and OLS intensity). Again setting aside the Great Lakes with "internal" $\overline{CS}$, the grand total across all fishing types, from table 7.9, ranges from 26 million dollars per year to -1.38 billion dollars per year. These results are disturbingly low, and suggest that a competitive effect occurs post-policy. That is, perhaps as freshwater quality improves along with Great Lakes and marine water quality, individuals switch from Great Lakes and marine fishing to freshwater fishing, which for most people will be closer to home and hence less expensive. Unfortunately, time and budget constraints did not permit us to test this hypothesis in a systematic fashion.

Since we did not have time to do the econometric work to include freshwater fishing benefits estimates in the same modeling framework as Great Lakes and marine fishing, we present below a second set of benefits estimated using assumptions that are broadly similar to those used in the earlier freshwater fishing work. In the 1982 freshwater study, we assumed that although the availability of Great Lakes and marine water was important in freshwater recreational fishing behavior, the changes in water availability post-policy would occur exclusively in freshwater. That is, we included a dummy variable (COAST) in our freshwater probability of participation models as a crude proxy for the availability of Great Lakes and marine fishing opportunity. COAST had a value of 1 if a respondent's home state had a Great Lakes and/or marine coastline, and a value of 0 if his or her home state was landlocked. In evaluating the benefits of freshwater fishing post-policy, however, we assumed that only freshwater bodies (excluding the Great Lakes) were affected by any particular pollution control policy. This assumption was, to some degree, required by the data then available, since we could not "locate" individuals at any level finer than their state of residence, and hence could not have calculated their distance-to-coast measures in any case.

The disturbing results in the evaluation of the Great Lakes and marine fishing models shown in the preceding section, raise the question what the project benefits would have been had we evaluated the models using the same assumption as was used earlier for freshwater fishing. This is the second broad scenario introduced earlier.

The evaluation below for the second scenario makes a number of assumptions. The first is, of course, that for evaluating benefits for a given fishing category, only that category's availability changes post-policy, while all other availabilities remain fixed at their pre-policy level. The second is that water in the relevant category is cleaned up as completely as possible with BAT, BCT, and BMP fully implemented. Finally, the evaluation assumes a value of $600 million per year for freshwater fishing benefits post-policy (Vaughan and Russell, 1982, p. 163), as a post-policy estimate of freshwater fishing benefits under a similar total-cleanup scenario.

In order to avoid stretching the reader's patience beyond reasonable limits, the results for only one of the twelve different model/evaluation methods used in the first scenario are shown here: OLS probability of participation, with STFWDIST as the local freshwater availability measure; the OLS intensity model (again with STFWDIST); and average consumer surplus values from Charbonneau and Hay (1978). For both Great Lakes, inshore saltwater, and offshore saltwater fishing, the respective values of $\bar{P}$ and $\bar{Q}$ are the same here as in the first scenario; only the ΔP's and ΔQ's change. The results of the evaluation are shown in table 7.10. $\bar{P}$'s and $\bar{Q}$'s are taken from table 7.6 - 7.8, while ΔP's and ΔQ's were developed using the same data as in the first scenario, excepting the changes in the availability measures. The grant total is $781 million dollars per year. The freshwater category contributes about 76 percent of this, while the Great Lakes contribute the rest. The reason the two marine categories show no benefits is that there is virtually no change in the marine availability measures.

Note that we do <u>not</u> assert that our benefit numbers would have been $600 million dollars per year for freshwater fishing had we estimated models for freshwater fishing and evaluated them under this scenario. Neither should this method of evaluation be viewed as more correct than the first, simultaneous-cleanup scenario. Instead, the second scenario has been presented to show a rough parallel to the earlier freshwater fishing work, and to illustrate some of the problems that can arise in estimating benefits of complementary recreation activities.

Table 7.10. Evaluation of Benefits under Scenario 2[a]

	Great Lakes Fishing	Inshore Saltwater Fishing	Offshore Saltwater Fishing	Freshwater Fishing[b]
$\overline{P}$[c]	0.016	0.087	0.035	--
ΔP[d]	0.0044	≈0	≈0	--
$\overline{Q}$[e]	10.8	12.8	6.0	--
ΔQ[f]	0.0541	0.00614	0.003	--
$\overline{CS}$[g]	21	22	73	--
Total Benefits[h]	79	2	0.1	600

Notes:

a. Assumes cleanup only of Great Lakes for Great Lakes evaluation, saltwater for inshore saltwater evaluation, etc.

b. Total benefits from Vaughan and Russell (1982) (See text).

c. Pre-policy probability of participation.

d. Change in probability of participation, post-policy.

e. Mean intensity of participation, pre-policy, in days/year.

f. Change in intensity, post-policy, in days/year.

g. Average consumer surplus (Charbonneau and Hay, 1978) in dollars/per/day.

h. $(\Delta Q\overline{P} \cdot \Delta P\overline{Q}) * \overline{CS} * 176{,}000{,}000$. In 10^6 dollars/year.

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Vaughan, William J. and Clifford S. Russell. 1982. Freshwater Recreational Fishing, The National Benefits of Water Pollution Control. (Washington, D.C.: Resources for the Future).

Chapter 8

SWIMMING DATA AND ESTIMATION

The estimation of recreational swimming benefits accuring through water pollution control will use the familiar two step- estimation of participation benefits (see chapter 3). This method is the same used in. previous work on recreational fishing (such as chapters 5 through 7 of this volume and Vaughan and Russell, 1982) and involves bifurcating benefit estimation into the estimation of participation and a separate valuation step.

As in the case of fishing and boating, we would like to be able to separate swimming participation by type of water body in which it takes place, that is, freshwater or marine. An additional complication with swimming is that a significance percentage of the activity occurs in a third type of "water body," namely pools. With the penultimate purpose of estimating the recreational swimming benefits of water pollution control, we are not interested in participation in this category of swimming, so any participation survey we might use <u>must</u> distinguish between pool and non-pool swimming, even if freshwater and marine swimming are aggegated.

Of the participation surveys available that include swimming as in activity, only the 1972 National Outdoor Recreation Survey meets the criteria of distinguishing between pool and non-pool swimming, and thus is is the survey we use. Unlike the surveys used in the fishing and boating analysis, this survey is designed to cover a plethora of activities is opposed to concentrating on a few of particular interest to the sponsor. While this is not inherently a problem for estimation, it does have the indirect effect of reducing the quality of data by limiting the detail of questions focused on the activity we are interested in. As we shall see, using this survey places additional limitations on the analysis to be performed.

Since the cross-sectional "macro" nature of the survey dictates a two step estimation of benefits, there are three issues to be considered (see chapter 1). How availability measures (and hence water quality) are included will be discussed in the section on data used in estimation. The functional form and method of estimation used on the model are discussed in the subsequent section. Results of estimation are reported in the next chapter on the second step of producing a benefit value for recreational swimming.

DATA FOR ESTIMATION WITH THE 1972 NATIONAL OUTDOOR RECREATION SURVEY

As is the case with most cross-sectional recreation participation surveys, the 1972 National Outdoor Recreation Survey (NORS72) contains information on the socioeconomic characteristics of the respondents and the recreational activities in which they engaged. This survey, which was conducted for the Department of Interior, concentrates on participation in outdoor recreation during the summer months of 1972. NORS72 covers all three of our water-based recreation activities, though it is of interest mainly for swimming. Of the 4029 personal interviews conducted, 3936 meet the qualifications of being households in the 48 contiguous states (not including the District of Columbia) for which socioeconomic data is also present whether the respondent participated or not. Since the survey contains very limited questions on individual travel costs or availability of recreation sites, NORS72 data is supplemented with data from our Supply Variables Data Base (see appendix D of chapter 5).

Participation Data and Dependant Variables

The NOHS72 survey consisted of personal interviews conducted with one randomly chosen individual in the household at least 12 years of age. The respondent was asked questions only on his/her participation, rather than household participation.. Sample weights attached to the survey data are designed to produce a representative sample of the civilian non-institutionalized population age 12 and over in the 48 contiguous states. Thus the unit of observation is the individual rather than the household.

The section of the survey on summer activities away from home is the section containing the questions of interest. Summer was defined to include only the months of June, July and August, so that only trips begun between June 1 and August 31 inclusive are considered in the survey. In 1972, both the Memorial Ray and Labor Day long weekends fell outside of this definition of summers though some Labor Day trips were included because they began in August.

Since a “trip is the proper unit of observation (McConnell, 1975), the distinction made in asking questions regarding the most recent vacation, the three previous overnight trips, day-long trips and short day trips is not a problem. In. fact, this provides us with more information, which information might well be argued to be not only nice but necessary. We can reasonably aggregate the most recent vacation and other three overnight trips into an overnight trip category, and the day-long outing and short day outing into a day trip category. This involves no loss of information on overnight trips and no loss of information on day trips if one assumes that long day outings and short day trips are essentially the same.

According to survey definitions, a day trip where more than four hours are spent away from home is a long day trip, whereas anything less than four hours constitutes a short day trip. Since travel time, which varies across individuals and trips, is included in this time away from home, the distinction between short and long day outings based on this particular criteria could be considered somewhat arbitrary. An obvious alternative would be to measure duration of trip as time away from home minus travel time, a measure which would not incongruously add together time which yields utility and time which yields disutility. Having no theory to support an hypothesis that there is a difference in the way individuals decide to participate in long days versus short days of recreation, we feel there is no reason to maintain the distinction.

It does, however, seem quite reasonable to hypothesize that there is a difference in the decisions to embark on a day trip as opposed to an overnight trip. Both types of trips involve two-way travel costs and the opportunity cost of time which, of course, vary with distance travelled and duration of trip. But overnight trips also involve other costs, for example, lodging costs. Since we do not have complete information in NORS72 on such expenses for all trips, we cannot fold the day and overnight categories together. Lacking data on a11 costs for both kinds of trips, it is impossible to estimate trip demand as a function of (among other things) total trip cost (regardless of duration), without the risk of bias in estimation.

The NORS72 survey form begins with questions on preferred activities in different seasons, the number of summer trips taken and dates, and then asks a set of questions on each of the four most recent overnight trips in the summer months. These questions cover the duration of trip, state in which the vacation took place, distance travelled, number of family members on trip, expenses, recreation activities participated in by days and hours per day. There are 29 activity categories for the NORS72 survey, with five water-based activities of interest to us. These activities include water skiing, canoeing, sailing, other boating and non-pool swimming. Thus, an individual may have reported that on a 10 day trip, non-pool swimming was an activity on 8 days, water skiing in 5 days and other boating on one day. This trip is then both a swimming and boating trip. The level of information does not allow us to completely determine how many days were spent soley on swimming, solely on boating, or on the two activities combined. Thus we cannot identify each day of a trip by particular member of a mutually exclusive set of activities and combinations of activities, and must use the trip as the unit of measure.

For individuals who participated in more than four overnight trips, information was also sought on the total number of additional days spent in each activity in the summer months. Thus, continuing the example of the individual above, a valid response might be that 10 "other" days were spent Swimming and that on 2 "other" days sailing was an activity. Here, we can make no complete determination about the number or trips represented by these days, let alone about the number of days spent swimming only, boating only or on a mix of the two activities. In fact, we can only back out the number of additional trips this data on "other" days, implies (for purposes of engaging in any of the 29 categories of recreation) by taking the total trips reported and subtracting the four already detailed. This number represents only an upper bound on the number of trips that were made for the purpose of engaging in water-based recreation in general. Also limiting the quality of the "other" days data is the fact that no ancillary questions such as those asked of the four most recent trips (length of trip, state, distance travelled, expenses, etc.) are asked in regard to these overnight trips. To the extent that we were able to determine the count of water-based recreation trips undertaken in “other” days of overnight trips, they were added to the appropriate total from the four most recent trips. However, the issue of how to distinguish trips by purpose or activity category(ies) remains.

While the activity of main interest to us here is swimming, individuals, as noted, often report engaging in boating and swimming on the same trip. To ignore the distinction possible in some cases between swimming only trips and mixed swimming and boating trips is to flirt with the double counting of benefits accruing through boating, which will be covered through a different method of estimation in chapters 10 and 11. Also, we must still contend with the aforementioned problems of trips reported as “other” days. To make best use of the information contained in the NORS72 survey, we created six dependent variables, which are the number of trips taken by the respondent, distinguished by duration (day versus overnight) and activity (swimming only, boating only or swimming and boating, with participation in non-water-based activities only considered to be non-participation).

Following the section of the questionnaire on overnight trips were similar sections on long day trips and short day trips. That is, a more detailed set of questions concerning the three most recent trips is following by less detailed questions regarding "other" days of participation for each of long and short day trips. Although a day trip is at once a day and a trip, making the earlier statement that the trip is the proper unit of measure of the dependent variable a moot point, we have the problem of determining how many days of "other" days are single purpose trips and how many are part of a multi-purpose trip. Data on the four most recent overnight trips and the three most recent each of long day and short day trips allows us to neatly places each of these trips into one of the six mutually exclusive dependent variable categories. These are named and defined in table 8.1. The steps necessary to derive the number of trips by category implied by the "other" days of participation data for overnight, long and short day trips are described in appendix 8.A.

The steps outlined in the appendix involved some choices. Some of the choices made were in answer to the following no-wrong-answer questions, with the particular choice of effecting the appropriateness of various methods of estimation. First, given the nature of the "other" days data, is it more reasonable to represent each respondent by a single value for each of the six dependent variables, or by a lower and upper bound for the six dependent variables? If the answer is a single value, then the question of whether or not to round a non-intager value begs an answer. Do days of participation in different types of boating imply distinct clays of participation because of the necessary access to the durable good (boat, whether owned, rented or borrowed)? Finally, there is the question of how to deal with contradictory data on and individual. More discussion of how these choices regarding the dependent variable measures affect estimation will follow in the section on estimation. We now turn to discussion of the independent variables to be used in our model, including socioeconomic variables and availability variables.

Table 8.1. Variables used in Estimation of Participation

Variable Name	Description	Source
I. DEPENDENT VARIABLES		
DAYSWIM	Number of (short and long) day trips taken where swimming is the only water-based recreation participated in.	NORS72, Coded
DAYBOAT	Number of (short and long) day trips taken where boating is the only water-based recreation participated in.	NORS72, Coded
DAYMIXED	Number of (short and long) day trips taken where both swimming and boating are likely to have been engaged in on the same trip.	NORS72, Coded
OVSWIM	Number of overnight trips taken where swimming is the only water-based activity participated in.	NORS72, Coded
OVBOAT	Number of overnight trips taken where boating is the only water-based activity engaged in.	NORS72, Coded
OVMIXED	Number of overnight trips taken where both swimming and boating are likely to have been engaged in on the same trip.	NORS72, Coded
II. SOCIOECONOMIC INDEPENDENT VARIABLES		
AGE	Age of survey respondent	NORS72,
AGESQ	AGE squared	Coded
FAMSIZE	Number of persons in household	NORS72
FIPS_ST	State of residence in FIPS codes	NORS72
INC	Estimated family pre-tax income for 1971, as midpoint of one of eight possible ranges, adjusted by state value of PHICKS72 (see below).	NORS72, Coded
INCSQ	INC squared	Coded
MARRIED	Marital status of head of household (not necessarily the respondent) where 1 means currently married, otherwise 0.	NORS72
METRO	Equal to 1 if respondent is an SMSA resident, otherwise 0.	NORS72

Table 8.1 (Continued)

NCENT	Equal to 1 if respondent is a resident of North central census region, 0 otherwise.	NORS72, Coded
NEAST	Equal to 1 if respondent is a resident of Northeastern census region, 0 otherwise.	NORS72, Coded
WEST	Equal to 1 if respondent is a resident of Western census region, 3 otherwise.	NORS72, Coded
SEX	Equal to 0 if male, 1 if female	NORS72
SUMEMP	Equal to 1 i employed during summer months, 0 if otherwise	NORS72
PHICKS72	Cross-sectional index of the Hicksian composite commodity price	Appendix 5.0
III. AVAILABILITY INDEPENDENT VARIABLES		
DOISHORE	Miles (calculated from Department of Interior data), of freshwater shoreline by state	Table IV.2 Appendix 5.B
MARDIST	State population-weighted (marine) distance to nearest Great Lakes or marine coast, in miles	Appendix 5.C
COASTWAT	State coastal waters to three miles offshore, in square miles	Table III.1 Appendix 5.B
STESTBAY	Area of state inland estuaries and bays, square miles	Table III.1 Appendix 5.B
SSURFARE	State surface area in square miles, including all water bodies	Appendix 5.C
SL_FRESH	State (lambda parameter) freshwater density, acres/acre	Appendix 5.C
POL	Fraction of water (freshwater, marine or Great Lakes) limited for recreation (swimming, small boating) due to pollution	Appendix 5.B
LIMIT	Fraction of water (freshwater, marine or Great Lakes) limited for recreation (swimming, small boating) due to reasons other than pollution	Appendix 5.B

Table 8.1 (continued)

SWIMDENS	State freshwater swimming density, calculated as $\frac{\text{DOISHORE} * 1760}{\sqrt{4840} * \text{SSURFARE} * 640}$	Appendices 5.B, 5.C 5.C
SWFUDENS	Swimming freshwater (unlimited) density, SWIMDENS * (1-LIMIT)	Coded
SWFPDENS	Swimming freshwater (polluted) density, SWIMDENS * (1-LIMIT) * POL	Coded
SWFUDIST	Swimming freshwater (unlimited), distance proxy, $\text{SWFUDENS}^{-1/2}$	Coded
SWFPDIST	Swimming freshwater (polluted) distance proxy, $\text{SWFUDENS}^{-1/2}$ * POL	Coded
SWMUDIST	Swimming marine (unlimited) distance, MARDIST / (1-LIMIT)	Coded
SWMPDIST	Swimming marine (polluted) distance, MARDIST * POL / (1-LIMIT)	Coded
BOFUDENS	Boating freshwater (unlimited) density, SL_FRESH * (1-LIMIT)	Coded
BOFPDENS	Boating freshwater (polluted) density SL_FRESH * (1-LIMIT) * POL	Coded
BOFUDIST	Boating freshwater (unlimited) distance proxy, $\text{BOFUDENS}^{-1/2}$	Coded
BOFPDIST	Boating freshwater (polluted) distance proxy, $\text{BOFUDENS}^{-1/2}$ * POL	Coded
BOMUDIST	Boating marine (unlimited) distance MARDIST / (1-LIMIT)	Coded
BOMPDIST	Boating marine (polluted) distance MARDIST * POL / (1-LIMIT)	Coded
SUMMRSUN	Percent age of possible sunshine during the months of June, July and August	Appendix 5.C

Socioeconomic Independent Variables

All of the socioeconomic independent variables originate from the NORS72 survey data and are also listed in table 8.1. The choice of these variables is culled from the literature (Deyak and Smith, 1978; Hay and McConnell, 1979; Settle, 1980; Russell and Vaughan, 1982) to suit our particular purposes in this model. A few comments about these variables are in order.

First, FAMSIZE is the number of persons in a household, not necessarily the number of persons on a trip, which is reported for the most recent trips where detailed questions are asked. Secondly, income is reported in the survey as falling in one of eight ranges, where the highest range is $35,000 and over.[2] For the first seven ranges, we use the midpoint of the range as the income level. To obtain a corresponding "mid-point" of the open-ended interval we use the Dagum Type I income distribution model (Kotz, Johnson and Read, 1983) fit to 1978 U.S. family income data, as follows. The lower bound of $35,000 is equivalent to $52,500 in 1978 dollars, which has a cumulative probability of 0.9669. The midpoint of the probability interval (0.9669, 1) is 0.9834, which is the cumulative probability of the "midpoint" of the open-ended range. Numerical solution yields $64,063 as the value in 1973 dollars, or $42,700 in 1972 dollars. The interval midpoints were then normalized by PHICKS72, which varies across states as an index of the price of a composite commodity for 1972 (Fuchs, Michael and Scott, 1979). Finally, residents of the three census regions represented by the included dummy variables have a value of one for the appropriate variable, while residents of the South are characterized by a value of zero for all three.

Availability Independent Variables

All of the data on the availability of recreation sites is from sources other than NORS72. Many of these other data sources have been merged to form the Supply Variables Data Base (see appendix 5.C), while additional data on pollution is collected in the RFF Recreational Water Availability Survey (see appendix 5.B). We would like to be able to match this availability data to the survey data at the finest level of spatial resolution possible. Raw availability measures are employable at the county level, though availability factors from the RFF Recreational Water Availability Survey are collected at the state level. However, NORS72 respondents can only be identified down to the state of residence, as no zip code or telephone exchange data is recorded on the survey data tape. Thus the availability measures are limited to the state level and are formed by aggregating the raw measures to the state level (where applicable) and correcting by the state level availability fractions.

The "local" availability variables (that is, pertaining to the respondent's state of residence) measure freshwater availability, by pollution scenario (both pre-policy and post-policy), by recreation activity (swimming and boating), and by type of measure (density or distance-proxy). In general, the difference between the pre- and post-policy variables for a particular activity/type-of-measure combination will be that, while both values are corrected for limitations other than pollution (assumed not to vary with scenario), only the pre-policy value is also corrected for limitations due to pollution, the assumption being that the policy implemented is complete cleanup.

The distinction by activity is the result of distinctions in both the raw availability measures and the limitations fractions by activity. To obtain a density measure we need measures of the area covered by water and surface area, the ratio of the two being the density of water. We restrict the water area measurement to include only freshwater for the following reasoning. Although both swimming and boating can occur in either freshwater or saline bodies and the dependent variables make no distinction between marine and freshwater, the object of the local availability variable is to capture the availability of all water relatively close to one's home, preferably in one's home county.

Since we cannot use a county level density we use the state level density, which is also the area-weighted average of county densities, as a proxy for the county density. With the objective of assigning to each respondent the most accurate data possible, a more reasonable way to weight the county densities for averaging would be by population. A quick way of population-weighting (since we do not have county population data in the Supply Variables Data Base) of the county densities of all water is to area-weighted the county freshwater densities, thus assuming that few counties have significant saline bodies, while area and population are somewhat correlated. While this is in fact the method we use to create a density of water for boating, swimming presents a different kind of problem.

In regards to boating, we can reasonably assume that the boatable freshwater measure represents the <u>area</u> of all potentially boatable water which is reduced by pollution and other limitations to give a measure of the density of boatable-quality water (Vaughan and Russell, 1984). The corrections for pollution and other limitations also come from the aforementioned survey. However, in the survey, the corrections for pollution and other limitations as they apply to (freshwater and marine) swimming are solicited on the basis of miles of shoreline, since the measure for swimming "areas" is typically length of shoreline (beaches). Creation of a density measure for swimming is not straightforward for this reason.

Drawing on the logic of Vaughan and Russell (1984), imagine that we conduct a series of trials, in each of which the outcome is the success or failure of finding a unit area water body covering the unit square of land in question. Now we wish to redefine the experiment so as to model the spatial distribution of swimming areas, often thought of as beach lengths but really including shallow areas beyond the beach as well. Imagine a large square region divided into a large number of small squares. A successful trial is one in which a swimming area covers the unit square in question, assuming we divide the region into the largest squares sufficiently small to guarantee that each is either covered completely by a swimming area, or does not contain any swimming area at all. Now it remains to find a way to "count" the number of such squares in our region of predetermined size.

Suppose that the region of interest is a state (usually on the order of hundreds of thousands or millions of acres) and that each trial square is one acre in size. One acre is a reasonable area to nearly fit the assumption that it be covered (or not covered) by a swimming area, which might be an acre pond, or a 70 yard length of beach (on a lake or river) extending 70 yards out from the beach (an area of approximately one acre). The "count" of water bodies of unit size is then the number of one acre ponds plus the number of 70 yard lengths of beach. Though we have no data on the count of one acre ponds we do have a measure of beach length (see table IV.2 of appendix 5.C).[4] Since this measure is in miles we convert to yards and divide by 70 yards ($\approx\sqrt{4840}$ yards) to obtain a "count" of one acre squares covered by swimming areas. Dividing this count by the number of acres in the state yields a density measure, which is proportional to the reciprocal of the expected distance from a random point in space to the nearest swimming site (see chapter 2).

Taking the conceptually incorrect step of dividing length (miles) of beach by surface area (square miles) and then treating it as a unitless density is tantamount to assuming that for each mile length of beach there is a square mile of swimming area extending one mile seaward. This is a very generous assumption which leads to a much larger density measure than that of the previously described measure. Using the state of New Jersey as an example, the data necessary to make both calculations are: state freshwater shoreline miles (DOISHORE) of 19,378 and state surface area (SSURFARE) of 8,220 square miles. The incorrect density calculation yields a value of 2.357 (miles/square mile), clearly showing the generosity of the implicit assumption of water area per shore length by producing a "density" that is greater than one! Following the less generous assumption of an acre of swimming area per 70 yard length of beach yields a unitless density value of 0.0932, a much more plausible estimate that is approximately one twenty-fifth of the previous estimate.

In keeping with the densities described above, we use (for both swimming and boating) the availability corrections as they apply to freshwater. The data collected in the water availability survey for boating was divided in two categories based on boat size. In creation of boating availability variables, we use the water quality data for small boats. Since we have no data on the size of boat used for recreation and we know that some boating involves water contact (e.g., water skiing) it is reasonable to assume that the decision to go boating is affected by the possibility of water contact (one aim of the small boat distinction) more often than not.

The final local availability variables are constructed in the following manner. First, a measure of the density of water-not-limited-by-pollution (for each activity) is created by multiplying the appropriate density by one minus the fraction of nonpollution limitations (again, measured for the appropriate activity). Then a measure of the density of this otherwise unlimited water which is limited by pollution is created by multiplying the previous product by the fraction limited due to pollution. This value represents the decrement in total availability caused by pollution. These measures are densities, and their distance counterparts are constructed as follows. First the expected distance to unlimited water bodies is calculated as the inverse square root of the density measure already corrected for limitations other than pollution. We do not multiply by 1/2 as in chapter 2, which leads to two interpretations. The first is that the 1/2 factor is perhaps not accurate and leaves the correct factor to be estimated along with the parameter estimate attached to the distance variable - a matter of scaling. The second interpretation is that the 1/2 factor is correct and that this variable represents the two-way travel cost. Whichever interpretation, the increment to travel distance caused by pollution is simply the distance to unlimited waters multiplied by the fraction of water limited due to pollution.

We include a second type of availability measure in contrast to the “local” variant - a “coastal" availability. The inclusion of this measure recognizes the fact that people often travel farther than the closest water body to participate in water-based recreation. Different quality attributes contribute to this otherwise irrational behavior, and thus we make a distinction between inland (freshwater) and coastal (marine) waters. There are four such availability measures, distinguished by pollution scenario (pre- and post-policy) and water-based activity (swimming or boating) - being all distance measures. First, the distance to the closest marine or Great Lakes coast is determined at a state level according to the distance sweeper program (see appendix 5.D). One should note however, that at the state level, such a measure may have a much greater variance than at a county level, and depends on the spatial distribution of population. This distance is then divided by one minus the fraction of water which is limited due to causes other than pollution, which effectively increases the distance that must be travelled to reach water suitable for recreation. This distance is then multiplied by the fraction of pollution limitations, to produce the increment to distance travelled which is necessary to reach unpolluted waters suitable for recreation.

A note about the sole climate variable, percentage of possible summer sunshine is in order. While other climate variables in the Supply Variables Database (see appendix 5.D) are available (on a monthly or annual basis), the average percentage of possible daily sunlight is chosen for two reasons. First, using the weighted (by days per month) average of the monthly averages for June, July and August provides a convenient way to include a climate variable pertinent to the time frame covered by the survey questions. Second, though we can easily make certain hypotheses about the effects of other climate/weather measures on participation (i.e., we would expect rainfall to be negatively correlated with swimming and boating, windspeed to be positively correlated with sailing, and temperature to be positively correlated with swimming participation), additional effects of these variables are not clear and important only to the extent that they better explain participation behavior for prediction purposes. Although percentage of summer sunshine is highly negatively correlated with rainfall in the appropriate months, the temporal nature of the percentage of possible sunshine measure allows it to be more easily interpreted as the probability that any day is well suited for outdoor recreation than other measures. A physical measure such as rainfall can vary across states which exhibit similar periods of rainfall. However, the variance in the amount of rainfall contributes little to the explanation of participation. In addition, this measure is already provided at the state level, accepting the caveat that in larger states weather in one area might have precious little to do with weather in another area. The value of SUMMRSUN varies from 59% to 89% with an arithmetic mean of 68.3%, and standard deviation of 6%, where the outliers tend to be above the mean.

Table 8.2 shows the variable means for key variables as national averages and by subsets of observations where complete information is available for swimming, for boating and for both activities combined. The main limiting factor causing loss of observations is the pollution data from the RFF water availability survey which lacks data on some states. This limitation results in the loss of all observations from some states which one might expect to be very important in the estimation of recreation benefits of water-pollution control. Eight states which lack availability values for both swimming and boating are Alabama, Florida, Georgia, Indiana, Maryland, Massachusetts, Nevada and Wyoming. To the extent that individuals in these states (representing approximately 15 percent of the population of the 48 contiguous states) are by nature different in their

Table 8.2. Sample Means

Variable	National Average	Observations with Complete Data by Activity		
		Swimming	Boating	Mixed Activities
METRO	0.627	0.576	0.618	0.541
INC	11013.3	10821.3	11066.9	10909.1
INCSQ	0.183E+9	0.175E+9	0.186E+9	0.178E+9
AGE	38.94	38.53	38.50	38.38
AGESQ	1881.26	1847.52	1841.34	1833.13
MARRIED	0.636	0.636	0.635	0.642
SUMEMP	0.504	0.497	0.495	0.484
FAMSIZE	3.903	3.987	3.904	3.970
SEX	0.524	0.528	0.521	0.523
NEAST	0.252	0.233	0.177	0.120
NCENT	0.278	0.371	0.325	0.433
WEST	0.164	0.057	0.212	0.066
SUMMRSUN	68.139	67.109	69.107	67.552
SWFUDENS	0.050	0.057	--	0.049
SWFPDENS[a]	0.007	0.008	--	0.009
BOFUDENS	0.018	--	0.018	0.020
BOFPDENS[a]	0.0008	--	0.0008	0.0009
SWFUDIST	6.189	4.988	--	5.250
SWFPDIST[a]	0.585	0.649	--	0.717
BOFUDIST	8.578	--	3.578	8.047
BOFPDIST[a]	0.490	--	0.490	0.493
SWMUDIST	196.944	194.138	--	213.296
SWMPDIST[a]	15.013	16.957	--	11.340
BOMUDIST	157.333	--	180.663	202.116
BOMPDISTa	2.367	--	2.478	3.194
Number of Observa- tions	3936[b]	2574	2918	2186

Notes:

a. For post-policy analysis these variables will have zero values as a result of complete cleanup.

b. Fewer than 3936 observations are used for the water availability variables due to incomplete coverage.

recreation habits than individuals in other states, estimation will be biased and produce incorrect benefit estimates. Six additional states are lost for lack of data in the swimming analysis, with two others dropped in the boating analysis.[5]

Table 8.3 shows variable means for observations with complete data where each subset contains only the data for individuals who reported a positive number of trips in the six dependent variable categories. Only in the category of swimming day trips is there at least one observation of participation per state for which availability data is present. That some states lack observations with positive participation in other categories is not a problem for estimation to the extent that individuals in these states do not actually participate, the main effect being a reduction in degrees of freedom. The category most affected by this, not surprisingly, is day trips for the mixed purposes of swimming and boating.

ESTIMATING RECREATION PARTICIPATION WITH NORS72

Having described the data available it remains to explore the related issues of hypothesis testing and model specification in the estimation of participation in swimming. The aim of this section is to motivate the choice of the particular method of estimation used after choosing the paradigm of the participation equation method. This motivation consists basically of eliminating the models catalogued in chapter 4, until only the actually estimated model remains. As will be seen, these models are eliminated more often by the second test nature of the data, rather than for lack of theoretical appeal.

The purpose of estimating a participation equation is to produce a quantity (or quantity change) of recreation to be valued in a later step.

Table 8.3. Sample Means of All Observations with Complete Data for Estimating Intensity of Participation Equations

	Swimming		Boating		Mixed Activities	
Variable	Days	Overnights	Days	Overnights	Days	Overnights
METRO	0.605	0.677	0.541	0.610	0.638	0.592
INC	12376.1	13152.5	14447.8	13306.0	13916.1	13437.4
INCSQ	0.212E+9	0.241E+9	0.296E+9	0.269E+9	0.257E+9	0.252E+9
AGE	26.47	29.50	30.89	35.25	25.15	27.64
AGESQ	845.93	1071.61	1132.54	1507.24	760.86	961.77
MARRIED	0.521	0.562	0.647	0.664	0.464	0.533
SUMEMP	0.464	0.456	0.371	0.424	0.338	0.425
FAMSIZE	4.685	4.395	4.078	3.752	4.435	4.301
SEX	0.572	0.500	0.462	0.456	0.531	0.546
NEAST	0.344	0.370	0.118	0.103	0.105	0.142
NCENT	0.307	0.241	0.288	0.271	0.372	0.446
WEST	0.064	0.069	0.232	0.364	0.121	0.074
SUMMRSUN	66.366	66.491	69.355	70.253	67.780	67.248
SWFUDENS	0.065	0.066	--	--	0.506	0.053
SWFPDENS[a]	0.010	0.012	--	--	0.007	0.010
BOFUDENS	--	--	0.019	0.018	0.023	0.021
BOFPDENS[a]	--	--	0.0008	0.0007	0.0010	0.0008
SWFUDIST	4.557	4.412	--	--	4.827	4.912
SWFPDIST[a]	0.658	0.716	--	--	0.597	0.689
BOFUDIST	--	--	8.236	8.797	7.329	7.928
BOFPDIST[a]	--	--	0.401	0.386	0.365	0.445
SWMUDIST	154.980	128.454	--	--	171.812	177.882
SWMPDIST[a]	17.125	16.409	--	--	7.065	11.479
BOMUDIST	--	--	171.943	181.349	126.606	209.881
BOMPDIST[a]	--	--	2.552	1.789	2.872	3.164
Number of Observations	433	333	198	177	81	156

Notes
a. For post policy scenario, these variables will have zero means after complete cleanup.

As indicated in the theoretical background presented in chapter 3, we may estimate structural demand for recreation econometrically rather than a reduced form, even without data on true prices, by using price proxies. The components of demand include an individual's income and tastes as well as the influence of the unknown prices. The variables of table 8.1 provide a means of measuring these components, though perhaps with error or in the nature of an expected value. To proceed with model specification we need to consider the mean relationship between the dependent and independent variables and the distribution of the stochastic disturbance.

We will assume that each set of models exhibit the same characteristics in terms of the distribution of the error terms, regardless of the dependent variable. In other words, for a given functional form of the demand equation, there are six distinct models, differing only in the dependent variable and (true) parameter values, having the same distribution of error terms and hence method of estimation. This assumption greatly simplifies the problem of determining models to be estimated.

Regardless of the functional form of the right hand side of the participation demand models, there are some further observations to be made about the structure of the dependent variables used. For instance, the dependent variables are observed with nonnegative values only, or can be said to have a distribution truncated at zero (not inclusive).

In a 1971 paper, Cragg proposed a set of models where the individual's behavior is the result of two decisions. The first decision in the dichotomous choice of whether to engage in a particular activity or not. The second decision is regarding the intensity of participation, conditional on the choice to participate in the first stage. These hurdles models seem to describe the recreation participation process quite well, while avoiding the danger inherent in using ordinary least squares (OLS) estimation on recreation participation data. When using OLS, biased and inconsistent parameter estimates are the result of violating the assumption that the disturbance terms are centered around zero.

One particular model which can be used to describe behavior which is characterized by either non-participation or some continuous level of participation is the Tobit estimator (Tobin, 1958). As shown in chapter 4, the likelihood function of a Tobit model can be broken into two models: a probit and truncated (at zero) normal. The Tobit is actually a special case of the two stage probit and truncated normal estimation where the parameter vector of the probit model is a scalar multiple (specifically, $1/\sigma$) of the parameter vector of the truncated normal model. A two stage model which is similar involves the probit first-stage model again, but uses OLS on the logarithm of the dependent variable for the second stage. The difference between these two-stage models of participation is due to the underlying distribution the positive dependent variable is assumed to have. In the first instance, the positive values are assumed to be truncated normal and in the second case, to be log-normal.

The methods of estimation for these types of models (Tobit, probit, and truncated normal) are well-known, and though more difficult to implement than OLS, are certainly easier and less costly than other sophisticated estimators. The assumption implicit in the methods of estimation discussed so far in this chapter is that the non-zero values of the dependent variable represent points from a continuous distribution. This assumption deserves some attention, as other estimates described in chapter 4 represent alternatives to this assumption.

The most obvious alternative model would assume that the dependent variable follows a discrete distribution where positive probability is attached to integer values greater than or equal to zero. There are two such estimators presented in chapter 4: one where the dependent variable follows the Poisson distribution and one following the geometric distribution. In both distributions, however, the expected value and variance are not independent of each other. This restriction may not characterize the dependent variable, and thus an estimator for the covariance matrix which is robust to departure from said dependence is necessary, making estimation more complex.

Another method of characterizing the dependent variable is to view it as an essentially continuous phenomena which can only be observed by intervals. A special case of interval data is one in which the intervals are represented by integers, whether the dependent variable is observed as such or rounded off to the nearest integer. The grouped dependent variable estimators due to Stewart (1983) and Rosett and Nelson (1975) assume that the underlying distribution of the dependent variable is normal, though it is measured as interval data. This method of estimation is much more complicated than the others already mentioned.

A reasonable argument could be make for using any of these estimators. The dependent variables as constructed from the survey data are in fact integer counts of trips. Since every trip involves twice the one-way travel cost, it would seem that only discrete distributions covering the nonnegative integers are appropriate. On the other hand, though it is not possible by definition to take a fraction of a trip, the method of constructing the dependent variable by using the number of trips of average length in “other” days of overnight, participation certainly allows for fractions of trips to be calculated. This suggests that it is reasonable to consider an integer count of trips as coming from a continuous distribution (with measurement error), despite the notion that trips are indivisible. The fact that fractional trips were rounded to the nearest integer value in constructing the dependent variable (to allow comparison with the reported total number of trips) is consistent with the hypothesis that the dependent variable is essentially continuous but measured at the integer midpoint of unit intervals.

The main risk in using a grouped dependent variable model is in misspecifying the intervals. In fact this will be a problem in our case. For a reported number of "other" days that is greater than zero but less than 1.5 times the average trip length in days, the number of additional trips is just one. Thus we cannot say on the surface whether a value of 3 for overnight trips is a particular category comes from the interval [2.5, 3.5) or (2.0, 3.5). We rule out use of a grouped dependent variable estimator on these grounds, since it seems unreasonable to redefine the dependent variables such that "other" days resulting in less than 0.5 times the average trip length are disregarded. Note that while we might have created an upper and lower bound without making any assumptions for each dependent variable for each respondent, the definition of intervals which do not overlap would have been impossible, again making the use of a grouped dependent variable estimator incorrect.

The issue of whether to treat the dependent variables as discrete or continuous still remains. Although it is measured discretely, we will assume that the random variable is a continuous one. The reasons are two-fold. First, we give credence to the fact that the dependent variable has fractional components, though counted, given the steps in variable construction. Second, we prefer to assume that the underlying distribution of the dependent variable is normal rather than Poisson or geometric. Though corrections are available in the discrete distribution estimates for violations of the assumed relationship between the mean and variance, it seems more appropriate to use an estimator based on the normal distribution.

The methods discussed thus far represent different ways to estimate first the probability of participation and then the intensity of participation conditional on a decision to participate, in each of the activity categories considered. That is, in the period covered by NORS72, each respondent makes a participate/don't participate decision for each of the six activity categories, followed by intensity decisions for the appropriate activities. Participation in any one category does not necessarily preclude participation in the remaining categories for the duration of the summer, though the categories themselves are constructed so as to be mutually exclusive. Instead of viewing the problem as six separate dichotomous probit (and intensity) models, we might use a single polychotomous logit or probit estimator which is useful in modeling the probability that an individual will make a particular choice given a finite number of mutually exclusive and exhaustive alternatives. By explicitly considering a seventh activity category to be non-participation, we have the requisite mutually exclusive and exhaustive choice set to use either of these methods of estimation. The advantage of estimating such a model is that the mutual exclusivity of the choices (i.e., the probabilities sum to one) allows us to determine the switching between the recreation categories, as well as the change in water-based participation versus non-participation as a result of policy implementation.

However, there are serious obstacles to overcome to be able to use a polychotomous logit or probit model, which center on the inability to unambiguously identify either days or trips with (mutually exclusive) activity categories. These obstacles arise in trying to define what constitutes a trial, and how many trials constitute the period of interest (here, the summer months). The obvious way to cover the summer months with a fixed number of trials is to define each day as a trial, and hence, to fold the overnight and day trip categories together for each activity category. Of course this would be nearly impossible to accomplish with the NORS72 data, even if we chose to ignore the dependencies which can occur between activity choices made on days that are part of the same trip. Even though we can identify trips by activity category with more confidence, the problem in using the trip as a trial is that trips have varying lengths. This results in a number of trials covering the summer months which is dependent on the number of trips and trip lengths. For these reasons, we abandon these choice models.[6]

Thus far we have narrowed our preference for methods of estimation down to those of the hurdle type model. Although the Tobit model need not be estimated as a two-step model, it is, as mentioned, a specific case of the more general two-step model which is a probit model of the probability of participation, followed by a truncated normal node1 of the intensity of participation, conditional on participation. We will not test the hypothesis of the restriction on the probit/truncated normal model which is tantamount to a Tobit model for the following reason. We are less interested in determining whether individuals exhibit similar behavior in both the participation and intensity stages than in simply determining their behavior pre-policy for prediction of post-policy behavior.

The choice between a truncated normal and log-normal distribution for the number of trips taken (conditional on participation explained in a probit model) cannot be made by a hypothesis test of nested models. In addition, neither model is significantly more appealing from a theoretical standpoint. Given the uncertainty regarding the actual nature of the data it is reasonable to use only the log-normal OLS estimator in the second step, which is a much less costly method of estimation. Thus our most preferred participation model is the two-step hurdles model where a probit and OLS on logarithms models are estimated.

The next chapter describes the results of estimation using the two-stage probit/OLS on logarithms model, and subsequent benefit estimation.

NOTES

1. "Away from home" refers to activities occurring away from the person's house, yard or apartment area.

2. The first seven income ranges were: under $3,000, 3,000 to 5,999, 6,000 to 7,999, 8,000 to 9,999, 10,000 to 14,999, 15,000 to 24,999, and 25,000 to 34,999. If the respondent did not offer data on income, the interviewer was encouraged to make an estimate.

3. A University of Kentucky Water Resources Institute survey (Bianchi, 1969) of over 3,300 fisherman reported that only slightly more than 8 percent travelled over 30 miles to fish. Similar calculations of the percent of days fishing in-county can be made from the 1980 NSHFWR as below:

One-Way Distance (miles)	Frequency (%)
0-5	19
6-24	26
25-49	17
50-99	14
100-249	10
250-499	3
500-999	1
>1000	Nil

The median travel distance from this actual data is 32 miles. The Davies test of skewness (Langley, 1970) suggests this data is approximately logarithmic in distribution, so the geometric mean is appropriate, yielding a value of 31.6 miles.

4. We invoke the same argument for using freshwater beach length as opposed to total beach length, noting that we do not have a measure of inland saline beach length.

5. The other states lacking swimming availability data are Arizona, California, Colorado, Pennsylvania, Rhode Island and Vermont. The other states lacking boating availability data were New York and West Virginia. Thus only 32 states are present in the analysis of trips where both activities are participated in.

6. See Morey (1981) for an example of a conditional logit model where time shares are estimated. Again, this model would be difficult to apply to the NORS72 data because of the inability to unambigously identify days by activity category. See also chapter 10 for an example of a single trial conditional logit model.

Appendix 8.A

DERIVING TRIP NUMBERS AND PURPOSES FOR “OTHER” DAYS OF PARTICIPATION in NORS72

1. For other overnight trips, if other days of participation were reported in only one of the five NORS72 water-based categories (swimming and four boating types), then the number of other days is divided by the average days per trip (for that respondent) in that category for the four most recent overnight trips in which that activity was participated in. This value represents the number of other trips that would be taken based on behavior reported in more detail on the four most recent trips. As this value may be a fraction, it is rounded to the nearest integer, with the exception that anything in the interval (0,1.5) is rounded to 1.

2. Since step 1 cannot be used where participation in other days includes more than one water-based recreation activity, or when the average days per trip for recreation in a particular category of the four most recent trips is zero, we must resort to other criteria. Fortunately, this occurs in only 28 cases out of the 86 in which a positive number of “other” days on overnight trips for one or more recreation categories was reported. These cases were studied individually to determine the number of trips in other days. Many of these individuals reported the same number of swimming days and boating days for the four most recent trips as well as other days on overnight trips, thus allowing an average days per trip calculation to be performed easily despite participation in two categories. In some instances the reported total number of overnight trips minus the four most recent (whether

for water-based recreation or not) implied a smaller number of additional trips than that which could be calculated by an average days per trip calculation similar to that in step 1.

3. For all individuals, the sum of the three mutually exclusive overnight trip counts from step 1 and the counts of "average trips" from step 2 is checked against the total reported overnight trips. If the total reported is greater than, equal to, or no more than one less than the sum, everything is considered copacetic. This is due to the potentially confusing nature of the questionnaire which asks whether a vacation was taken in the summer and its dates, and then asks for the number of overnight trips. The answer may or may not include the most recent vacation, depending on how the individual interpreted the question. In fact, the only instances in which this condition was not met was for individuals who only reported swimming as an activity in other overnight trips. In this case, we assume that the individual correctly reported the total number of overnight trips and that those prior to the four most recent were longer on average. Thus the number of swimming overnights other than the four most recent trips is set so as not to exceed the number of reported trips.
4. Turning to day trips, when only swimming was reported as an activity in "other" long days or "other" short days, the values reported were simply added to produce the initial count of swimming only day trips.
5. When only boating categories were reported for "other" long days or "other" short days, the values of day trips for sailing plus trips for canoeing were included in the count of boating only days. This

assumes that due to the different boating durable good requirements of these two boating activities, it is likely that an individual only participates in one of these kinds of boating in a day, thus each day of each kind represents a single trip. Also, water skiing and other boating are assumed not to occur on the same day as sailing or canoeing, though we do not assume that water skiing and other boating cannot occur on the same day. Thus we also include in the count of boating day trips the maximum of water skiing or other boating short days and the maximum of water skiing or other boating long days.

6. When both swimming and boating were reported activities in either “other” long days or "other” short days, it is impossible to say definitively whether these days correspond to single activity trips, dual activity trips, or some of both types. In most of these instances, the number of day trips already assigned (in the fashion of steps 4 and 5) to a category and the total number of day trips reported taken allow for an additional number of day trips (to be assigned to either single activity or dual activity trips) which is smaller than the number of “other” days reported in just one activity alone. For instance, one individual who reports only 16 total long day trips and no short day trips also reports (in addition to his three most recent long day trips for non-water-based recreation) 20 long day trips for water-skiing and 40 long day trips for swimming - clearly contradictory answers. Since there is no obvious reason to believe that the reported total long day trips is more likely to be accurate than the days reported by activity, and vice-versa, we count the minimum number of days

for “other long day trips” (or “other short day trips”) in the water-based recreation activities as the number of mixed activity long (or short) days. This strikes a compromise between asserting the validity of the total reported trips, which would generally entail counting all day trips as mixed days and still not counting some days of reported activity, and the validity of the days reported in each activity, which would lend no credence to the answer reported for the total day trips questions. This situation occurs in 25 cases.

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Chapter 9

SWIMMING BENEFITS: PARTICIPATION AND EVALUATION

The previous chapter described the data used in the analysis of swimming participation and made the case for the principal estimation method: probit for the probability of some participation and ordinary least squares (OLS) on the logarithms of days of participation, for the intensity of participation, given that some participation takes place. In this chapter, the results of application of these methods are discussed and benefits are calculated using values from the literature for days of swimming and boating. In addition, to provide a familiar if not methodologically correct comparison, results are presented using OLS for both stages of the estimation and not using the logs of participation intensity in that stage.

MODEL DEFINITION

The models estimated are distinguished by the type of activity and duration of trip, by the way in which site availability (the price proxy or its inverse) is included and by the restrictions placed on the coefficients of the variable reflecting loss of availability due to pollution. The resulting alternative models are listed and named in table 9.1. Since each model is estimated in two ways, the total number of estimations is 72.

For every model, the socioeconomic variables are the same. The availability variable is the one appropriate to the activity: swimming availability for the swimming activities, boating availability for the boating activities, and both availability measures for the mixed activities. These availability measures all include both local freshwater

Table 9.1. Models Estimated

Model	Trips Variable Used to Create Dependent Variable	Model Restrictions	Type of Freshwater Measures
SMOD1	DAYSWIM	General	Acres/Acre
SMOD2	DAYSWIM	Skeptic	Acres/Acre
SMOD3	DAYSWIM	Environmental	Acres/Acre
SMOD4	DAYSWIM	General	$(\text{Acres/Acre})^{-1/2}$
SMOD5	DAYSWIM	Skeptic	$(\text{Acres/Acre})^{-1/2}$
SMOD6	DAYSWIM	Environmental	$(\text{Acres/Acre})^{-1/2}$
SMOD7	OVSWIM	General	Acres/Acre
SMOD8	OVSWIM	Skeptic	Acres/Acre
SMOD9	OVSWIM	Environmental	Acres/Acre
SMOD10	OVSWIM	General	$(\text{Acres/Acre})^{-1/2}$
SXOD11	OVSWIM	Skeptic	$(\text{Acres/Acre})^{-1/2}$
SMOD12	OVSWIM	Environmental	$(\text{Acres/Acre})^{-1/2}$
BMOD1	DAYBOAT	General	Acres/Acre
BMOD2	DAYBOAT	Skeptic	Acres/Acre
BMOD3	DAYBOAT	Environmental	Acres/Acre
BMOD4	DAYBOAT	General	$(\text{Acres/Acre})^{-1/2}$
BMOD5	DAYBOAT	Skeptic	$(\text{Acres/Acre})^{-1/2}$
BMOD6	DAYBOAT	Environmental	$(\text{Acres/Acre})^{-1/2}$
BMOD7	OVBOAT	General	Acres/Acre
BMOD8	OVBOAT	Skeptic	Acres/Acre
BMOD9	OVBOAT	Environmental	Acres/Acre
BMOD10	OVBOAT	General	$(\text{Acres/Acre})^{-1/2}$
BMOD11	OVBOAT	Skeptic	$(\text{Acres/Acre})^{-1/2}$
BMOD12	OVBOAT	Environmental	$(\text{Acres/Acre})^{-1/2}$
MMOD1	DAYMIXED	General	Acres/Acre
MMOD2	DAYMIXED	Skeptic	Acres/Acre
MMOD3	DAYMIXED	Environmental	Acres/Acre
MMOD4	DAYMIXED	General	$(\text{Acres/Acre})^{-1/2}$
MMOD5	DAYMIXED	Skeptic	$(\text{Acres/Acre})^{-1/2}$
MMOD6	DAYMIXED	Environmental	$(\text{Acres/Acre})^{-1/2}$
MMOD7	OVMIXED	General	Acres/Acre
MMOD8	OVMIXED	Skeptic	Acres/Acre
MMOD9	OVMIXED	Environmental	Acres/Acre
MMOD10	OVMIXED	General	$(\text{Acres/Acre})^{-1/2}$
MMOD11	OVMIXED	Skeptic	$(\text{Acres/Acre})^{-1/2}$
MMOD12	OVMIXED	Environmental	$(\text{Acres/Acre})^{-1/2}$

measures (based on jurisdiction of residence) and marine coast proxies based on distance.

Parameter Restrictions

The restrictions on parameter values corresponding to what are referred to as the general, skeptic, and environmentalist models can be summarized by reference to the following general expressions (applying to participation probability or intensity). First, define:

$$\underline{X}\beta = \beta_2 \text{ INC} + \beta_3 \text{ INCSQ} + \beta_4 \text{ AGE} +$$
$$\beta_5 \text{ AGESQ} + \beta_5 \text{ MARRIED} + \beta_7 \text{ SUMEMP} + \beta_8 \text{ SUMEMP} + \beta_8 \text{ FAMSIZE} +$$
$$\beta_9 \text{ SEX} + \beta_{10} \text{ NEAST} + \beta_{11} \text{ NCENT} + \beta_{12} \text{ WEST} + \beta_{13} \text{ SUMMRSUN}$$

then the following right-hand-side forms are used.

I. Swimming Models

A. Density Version of Availability Variables (SMOD 1,2,3,7,8,9)

Then $\underline{X}\beta + \beta_{14} \text{ SWFUDENS} + \beta_{15} \text{ SWFPDENS} + \beta_{16} \text{ SWMUDIST} + \beta_{17} \text{ SWMPDIST}$

B. Distance Version of Availability Variables (SMOD 4,5,6,10,11,12)

$\underline{X}\beta + \beta_{14} \text{ SWFUDIST} + \beta_{15} \text{ SWFPDIST} + \beta_{16} \text{ SWMUDIST} + \beta_{17} \text{ SUMPDIST}$

II. Boating Models

A. Density Version of Availability Variables (BMOD 1,2,3,7,8,9)

$\underline{X}\beta + \beta_{14} \text{ BOFUDENS} + \beta_{15} \text{ BOFPDENS} + \beta_{16} \text{ BOMUDIST} + \beta_{17} \text{ BOMPDIST}$

B. Distance Version of Availability Variables (BMOD 4,5,6,10,11,12)

$\underline{X}\beta + \beta_{14} \text{ BOFUDIST} + \beta_{15} \text{ BOFPDIST} + \beta_{16} \text{ BOMUDIST} + \beta_{17} \text{ BOMPDIST}$

III. Mixed Activity Model

A. Density Version of Availability Variables (MMOD1 ,2,3,7,8,9)

$\underline{X}B + \beta_{14}$ SWFUDENS $+ \beta_{15}$ SWFPDENS $+ \beta_{16}$ SWMUDIST $+ \beta_{17}$ SWMPDIST $+ \beta_{18}$ BOFUDENS $+ \beta_{19}$ BOFPDENS $+ \beta_{20}$ BOMUDIST $+ \beta_{21}$ BOMPDIST

B. Distance Proxy Version of Availability Variables (MMOD 4,5,6,10,11,12)

$\underline{X}B + \beta_{14}$ SWFUDIST $+ \beta_{15}$ SWFPDIST $+ \beta_{16}$ SWMUDIST $+ \beta_{17}$ SWMPDIST $+ \beta_{18}$ BOFUDIST $+ \beta_{19}$ BOFPDIST $+ \beta_{20}$ BOMUDIST $+ \beta_{21}$ BOMPDIST

Recall that the environmental hypothesis is that pollution simply reduces availability and that only net availability makes any difference to participation decisions. The skeptic(al) view is that pollution makes <u>no</u> difference and that participation decisions are influenced only by gross availability. The general view or model is that both gross availability and the effect of pollution have independent effects on participation decisions. These hypotheses translated into restrictions on the coefficients in the following way:

	Environmental	Skeptic	General
Density Version	$\beta_{14}=-\beta_{15};\beta_{16}=\beta_{17}$ $[\beta_{18}=-\beta_{19};\beta_{20}=\beta_{21}]$	$\beta_{15}=\beta_{17}=$ $[=\beta_{19}=\beta_{21}]=0$	No restrictions
	SMOD 3,9	SMOD 2,8	SMOD 1,7
	BMOD 3,9	SMOD 2,8	BMOD 1,7
	MMOD 3,9	MMOD 2,8	MMOD 1,7
Distance Version	$\beta_{14}=\beta_{15};\beta_{16}=\beta_{17}$ $[\beta_{18}=\beta_{19};\beta_{20}=\beta_{21}]$	$\beta_{15}=\beta_{17}$ $_{19}=\beta_{21}]=0$	No restrictions
	SMOD 6,12	SMOD 5,11	MOD 4,10
	BMOD 6,12	BMOD 5,11	BMOD 4,10
	MMOD 6,12	MMOD 5,11	MMOD 4,10

Notice that there is a difference between the density and distance versions of the models in the restrictions on the parameters attached to the pollution effect on local freshwater. This is because, as explained in chapter 8, in the density version, pollution is taken as a reduction in availability. In the distance models the pollution effect variable is taken as an increment to distance. Thus, in the density models the gross availability and pollution-effect variables are expected to enter with opposite signs, while in the distance models they are expected to enter with the same signs.[1]

Expected Parameter Signs

Some additional comments about the expected influence of the independent variables should also be made. Many of the independent variables are intended to capture the effects of differences in individuals' tastes, with the direction of influence not dictated by economic theory. For instance, the influence of FAMSIZE is likely to vary by activity category and duration of trip, so we do not have an hypothesis about its influence. This is likely to be the case for the regional dummy variables, and age, sex, and marriage variables.

The influence of the INCOME, METRO, SUMEMP and SUMMRSUN variables are more closely related to economic theory. If we believe that recreation is a normal good, we would expect a positive sign on INC and a negative sign on INCSQ. The METRO variable is hypothesized to have an effect somewhat similar to that of price. Since there are likely to be more recreation opportunities outside of metropolitan areas, individuals with a METRO value of one are likely to be more inclined to take overnight trips than day trips as the travel cost of a day trip is then high relative to the utility gained from the short time spent recreating. The higher a value of SUMMRSUN, the more likely it is that any day is suitable for recreation, with a high value indirectly implying a lower price through more recreation opportunities.

The SUMEMP variable captures simultaneously the earning of a positive amount of income and a constraint on the amount of time available for recreation. Thus, the expected sign of the SUMEMP parameter depends on whether the time constraint or the budget constraint is more binding in a household production framework.

ESTIMATION RESULTS

There are actually four regressions for every model listed in table 9.1. First, a probit model using a 1/0 participate/don't participate transformation of the dependent variable is estimated in the probability of participation stage of the sophisticated two-stage method. The parameter estimates from these models are presented in tables 9.2 through 9.7. A naive version of these models, which is estimated using OLS, is used only in subsequent tables on benefit estimates, the parameters not being presented here. The second stage of the model is then estimated using OLS on the natural logarithm of the observations which represent positive participation is each category. The parameter estimates from these models are presented in table 9.8 through 9.13. As in the probability of participation stage, a naive version is also estimated using just the observed value of the dependent variable for observations with positive participation. Again these results are used only to show the effect on benefit estimates and are not otherwise reported.

The disappointing character of the results in these tables should not be concealed by the sheer quantity of numbers. Many parameters are not significant at all. Some others are significant in the models for one or two activities. In only a very few cases are the parameters for which signs were hypothesized significant and of the proper sign for even one

Table 9.2. Probit Regressions for Probability of Participation in Swimming Only: Day Trips

Variable/Model	SMOD1	SMOD2	SMOD3	SMOD4	SMOD5	SMOD6
Constant	-0.628 (-0.884)	-0.131 (-0.200)	-0.104 (-0.168)	-0.0316 (-0.046)	0.0974 (0.151)	0.0186 (0.029)
METRO	-0.020 (-0.290)	-0.022 (-0.312)	-0.020 (-0.286)	-0.048 (-0.692)	-0.043 (-0.613)	-0.0319 (-0.459)
INC	0.00002 (1.568)	0.00002 (1.647)	0.00002 (1.646)	0.00002 (1.512)	0.00002 (1.545)	0.00002 (1.560)
INCSQ	-0.26E-9 (-0.830)	-0.27E-9 (-0.885)	-0.27E-9 (-0.872)	-0.25E-9 (-0.799)	-0.24E-9 (-0.780)	-0.24E-9 (-0.788)
AGE	-0.0081 (-0.590)	-0.0072 (-0.523)	-0.0072 (-0.525)	-0.0077 (-0.558)	-0.0073 (-0.529)	-0.0072 (-0.521)
AGESQ	-0.0003 (-1.798)	-0.0003 (-1.361)	-0.0003 (-1.861)	-0.0003 (-1.817)	-0.0003 (-1.846)	-0.0003 (-1.859)
MARRIED	0.104 (1.097)	0.101 (1.075)	0.103 (1.096)	0.096 (1.018)	0.101 (1.073)	0.103 (1.096)
SUMEMP	-0.0148 (-0.206)	-0.0193 (-0.269)	-0.0199 (-0.278)	-0.3172 (-0.238)	-0.0180 (-0.250)	-0.0175 (-0.243)
FAMSIZE	0.0325 (1.947)	0.0319 (1.916)	0.0320 (1.926)	0.0369 (2.186)	3.0376 (2.234)	0.0357 (2.129)
SEX	0.149 (2.110)	0.152 (2.156)	0.152 (2.159)	0.152 (2.147)	0.151 (2.129)	0.149 (2.119)
NEAST	0.464 (3.115)	0.296 (2.375)	0.317 (2.786)	0.344 (2.699)	0.287 (2.796)	0.316 (3.093)
NCENT	0.0104 (0.124)	-0.0184 (-0.224)	-0.0186 (-0.225)	0.0305 (0.361)	0.0015 (0.018)	-0.0132 (-0.160)
WEST	0.183 (1.276)	0.221 (1.558)	0.214 (1.519)	0.448 (2.781)	0.402 (2.611)	0.308 (2.095)
SUMMRSUN	-0.0029 (-0.297)	-0.0101 (-1.542)	-0.0103 (-1.168)	-0.0062 (-0.645)	-0.0081 (-0.916)	-0.0080 (-0. 802)
SWFUDENS	2.900 (1.695)	1.382 (0.895)	1.305[a] (0.310)			
SWFPDENS	-5.389 (-1.473)	0.0[a]	-1.305[a] (0.940)			
SWFUDIST				-0.0702 (-3.168)	-0.3671 (-3.572)	[illegible][a] [illegible]
SWPDIST				0.3613 (1.116)	0.0[a]	[illegible][a] [illegible]
SWMUDIST	0.00006 (0.386)	-0.30010 (-0.795)	-0.00011[a] (-0.910)	0.0002 (0.163)	0.0002 (0.134)	[illegible][a] [illegible]
SWMPDIST	-0.0056 (-2.036)	0.0a	-0.00011[a] (-0.910)	-0.0018 (-0.796)	0.0[a]	[illegible][a] [illegible]
N of OBS	2574	2574	2574	2574	2574	2574
Log L	-1035.61	-1037.74	- 037.83	-1031.49	-1033.52	-1035.3

Note:

a. Parameter constrained.

Table 9.3. Probit Regressions for Probability of Participation in Swimming Only: Overnights Trips

Variable/Model	SMOD7	SMOD8	SMOD9	SMOD10	SMOD11	SMOD12
Constant	-1.376	-1.028	-1.008	-0.932	-0.891	-1.047
	(-1.898)	(-1.520)	(-1.506)	(-1.327)	(-1.333)	(-1.567)
METRO	0.182	0.194	0.196	0.158	0.169	0.182
	(2.462)	(2.630)	(2.674)	(2-144)	(2.298)	(2.478)
INC	0.00003	0.00003	0.00003	0.00003	0.00003	0.00003
	(2.784)	(2.862)	(2.817)	(2.742)	(2.834)	(2.844)
INCSQ	-0.45E-9	-0.45E-9	-0.45E-9	-0.43E-9	-0.43E-9	-0.44E-9
	(-1.542)	(-1.546)	(-1.535)	(-1.472)	(-1.490)	(-1.512)
AGE	-0.00178	-0.00145	-0.00165	-0.00142	-0.00119	-0.00137
	(-0.141)	(0.114)	(-0.131)	(-0.112)	(-0.094)	(-0.108)
AGESQ	-0.00024	-0.00024	-0.00024	-0.00024	-0.00024	-0.00024
	(-1.532)	(-1.566)	(-1.553)	(-1.544)	(-1.568)	(-1.564)
MARRIED	0.0452	0.0543	0.0512	0.045	0.054	0.356
	(0.476)	(0.571)	(0.539)	(0.470)	(0.571)	(0.583)
SUMEMP	0.0857	0.0825	0.0827	3.0837	0.0834	0.0835
	(1.138)	(1.097)	(1.100)	(1.105)	(1.103)	(1.108)
FAMSIZE	-0.0088	-0.0074	(-0.0087	-0.5030	-0.0013	-0.0042
	(-0.483)	(-0.410)	-0.479)	(-0.161)	(-0.073)	(-0.230)
SEX	-0.110	-0.109	-0.108	-0.108	-0.111	-0.111
	(-1.511)	(-1.493)	(-1.484)	(-1.473)	(-1.520)	(-1.519)
NEAST	0.273	0.259	3.320	0.238	0.187	0.239
	(1.783)	(2.025)	(2.750)	(1.805)	(1.773)	(2.293)
NCENT	-0.215	-0.240	-0.233	-0.175	-0.219	-0.273
	(-2.401)	(-2.751)	(-2.658)	(-1.935)	(-2.489)	(-2.651)
WEST	0.254	0.238	0.233	0.504	0.410	0.303
	(1.737)	(1.646)	(1.618)	(3.089)	(2.625)	(2.019)
SUMMRSUN	0.0048	-0.00006	0.00064	0.0023	0.0020	0.3025
	(0.489)	(-0.007)	(0.070)	(0.230)	(0.215)	(0.267)
SWFUDENS	0-552	0.057	-1.106[a]			
	(0.304)	(0.035)	(-0.776)			
SWFPDENS	3.559	0.0[a]	1.106[a]			
	(0.943)		(-0.776)			
SWFUDIST				-0.0725	-0.0659	-0.0307[a]
				(-2.875)	(-2.687)	(-1.509)
SUFPDIST				0.123	0.0[a]	-0.0307[a]
				(2.137)		(-1.509)
SWMUDIST	-0.00031	-0.00039	-0.00042[a]	-5.00022	-0.00021	-0.00031[a]
	(-1.589)	(-2.182)	(-2.436)	(-1.154)	(-1.217)	(-1.725)
SWMPDIST	-0.00216	0.0[a]	-0.00042[a]	-5.00190	0.0[a]	-0.00031[a]
	(-0.734)		(-2.436)	(-0.805)		(-1.725)
N of OBS	2574	2574	2574	2574	2574	2574
Log L	-935.239	-937.188	-936.607	-929.136	-933.198	-935.731

Note:
a. Parameter constrained.

Table 4.4. Probit Regressions for Probability of Participation Boating Only: Day Trips

Variable/Model	BMOD1	BMOD2	BMOD3	BMOD4	BMOD5	BMOD6
Constant	-1.298 (-1.787)	-1.275 (-1.811)	-1.250 (-1.778)	-1.152 (-1.670)	-1.171 (-1.793)	-1.137 (-1.748)
METRO	-0.188 (-2.321)	-0.188 (-2.335)	-0.189 (-2.344)	0.178 (-2.197)	-0.179 (-2.220)	-0.181 (-2.238)
INC	0.46E-4 (3.521)	0.45E-4 (3.480)	0.45E-4 (3.476)	0.46E-4 (3.498)	0.46E-4 (3.499)	0.46E-4 (3.496)
INCSQ	-0.57E-9 (-1.899)	-0.56E-9 (-1.855)	-0.56E-9 (-1.850)	-0.5769 (-1.884)	-0.57E-9 (-1.8861	-0.57319 (-1.885)
AGE	0.0194 (1.276)	0.0204 (1.339)	0.0204 (1.343)	0.0204 (1.340)	0.0254 (1.341)	0.0205 (1.348)
AGESQ	-0.00047 (-2.456)	-0.00048 (-2.504)	-0.00048 (-2.506)	-0.00048 (-2.506)	-0.00048 (-2.507)	-0.0048 (-2.513)
MARRIED	0.123 (1.155)	0.116 (1.089)	0.116 (1.088)	0.116 (1.089)	0.116 (1.089)	0.115 (1.088)
SUMEMP	-0.3978 (-1.126)	-0.0944) (-1.088)	-0.0947 (-1.092)	-0.0887 (-1.020)	-0.0888 (-1.321)	-0.0884 (-1.016)
FAMSIZE	-0.040 (-1.877)	-0.038 (-1.304)	-0.038 (-1.301)	-0.039 (-1.814)	-0.039 (-1.314)	-0.539 (-1.809)
SE	-0.3678 (-0.811)	-0.0688 (-0.823)	-0.0687 (-0.822)	-0.0724 (-0.865)	-0.0724 (-0.865)	-0.0730 (-0.872)
YEAST	-0.378 (-2.631)	-0.355 (-2.502)	-0.358 (-2.509)	-0.335 (-2.351)	-0.335 (-2.350)	-0.335 (-2.353)
NCENT	-0.126 (-1.198)	-0.098 (-0.372)	-0.099 (-0.979)	0.062 (-5.571)	-0.063 (-0.596)	-0.063 (-0.587)
WEST	-0.014 (-0.109)	-0.319 (-0.155)	0.522 (-0.181)	0.030 (0.199)	0.320 (0.160)	0.007 (0.059)
SUMMRSUN	-0.50376 (-0.388)	-0.00428 (-0.468)	-0.00453 (-0.495)	-0.00273 (-0.271)	-0.00251 (-0.271)	-0.00334 (-0.370)
BOFUDENS	1.109 (0.334)	2.243 (0.714)	1.989[a] (0.617)			
BOFPDENS	39.532 (1.067)	0.0[a]	-1.989[a] (0.617)			
BOFUDIST				-0.0275 (-1.321)	-0.3263 (-1.302)	-5.2215[a] (-1.276)
BOFPDIST				0.50517 (0.053)	0.0[a]	-0.0215[a] (-1.276)
BOMUDIST	-0.00014 (-0.745)	-0.00016 (-0.361)	-0.00016[a] (-0.881)	-0.50012 (-0.617)	-0.00012 (-0.655)	-0.00014[a] (-0.761)
BOMPDIST	0-00074 (0.092)	0.0[a]	-0.00016[a] (-0.881)	0.00106 (0.125)	0.0[a]	-0.00014[a]
N of OBS	2918	2918	2918	2918	2918	2918
Log L	-686.897	-637.461	-687.524	-686.849	-686.857	-6d6.391

Note:
a. Parameter constrained.

Table 9.5. Probit Regressions for Probability of Participation in Boating Only: Overnight Trips

Variable/Model	BMOD7	BMOD8	BMOD9	BMOD10	BMOD11	BWOD12
Constant	-0.703 (-1.017)	-0.546 (-0.808)	-0.533 (-0.789)	-0.517 (-0.789)	-0.369 (-0.589)	-0.370 (-0.592)
METRO	-0.0238 (-0.284)	-0.0179 (-0.214)	-0.0185 (-0.222)	-0.030 (-0.356)	-0.0214 (-0.255)	-0.0217 (-0.0259)
INC	0.171E-4 (1.324)	0.166E-4 (1.290)	0.166E-4 (1.288)	0.167E-4 (1.294)	0.166E-4 (1.286)	0.166E-4 (1.287)
INCSQ	-0.962E-9 (-0.322)	-0.84E-10 (-0.290)	-0.86F-10 (-0.287)	-0.87E-10 (-0.292)	-0.86E-10 (-0.287)	-0.86E-10 (-0.288)
AGE	0.0169 (1.263)	0.0171 (1.279)	0.0171 (1.281)	0.0172 (1.289)	0.0172 (1.289)	0.0172 (1.287)
AGESQ	-0.00029 (-1.885)	-0.00030 (-1.889)	-0.00030 (-1.890)	-0.00030 (-1.903)	-0.00030 (-1.896)	-0.00030 (-1.894)
MARRIED	0.0587 (0.573)	0.0563 (0.550)	0.0564 (0.551)	0.0597 (0.583)	0.0588 (0.575)	0.0590 (0.577)
SUMEMP	0.00451 (0.051)	0.00636 (0.073)	0.00631 (0.072)	0.00451 (0.051)	0.00290 (0.033)	0.00283 (0.032)
FAMSIZE	-0.0575 (-2.493)	-0.0563 (-2.458)	-0.0562 (-2.455)	-0.0565 (-2.451)	-0.0564 (-2.463)	-0.0564 (-2.463)
SEX	-0.125 (-1.484)	-0.126 (-1.493)	-0.126 (-1.491)	-0.125 (-1.477)	-0.125 (-1.483)	-0.125 (-1.482)
NEAST	-0.345 (-2.280)	-0.329 (-2.207)	-0.320 (-2.201)	-0.357 (-2.388)	-0.353 (-2.364)	-0.353 (-2.359)
NCENT	-0.0624 (-0.555)	-0.0319 (-0.297)	-0.0310 (-0.287)	-0.0685 (-0.603)	-0.0488 (-0.439)	-0.0481 (-0.429)
WEST	0.440 (3.284)	0.493 (4.039)	0.491 (4.025)	0.394 (2.616)	0.475 (3.764)	0.475 (3.843)
SUMMRSUN	-0.0139 (-1.501)	-0.0168 (-1.896)	-0.0169 (-1.912)	-0.0164 (-1.702)	-0.0185 (-2.067)	-0.0185 (-2.101)
BOFUDENS	1.458 (0.424)	2.228 (0.686)	2.124[a] (0.636)			
BOFPDENS	15.725 (0.410)	0.0[a]	-2.124[a] (0.636)			
BOFUDIST				0.00723 (0.290)	-0.00027 (-0.014)	-0.00029[a] (-0.017)
BOFPDIST				-0.0307 (-0.324)	0.0[a]	-0.00029[a] (-0.017)
BOMUDIST	0.000139 (0.770)	0.69E-4 (0.407)	0.628E-4[a] (0.373)	0.976E-4 (0.511)	0.503E-4 (0.288)	[illegible][a] [illegible]
BOMPDIST	-0.00918 (-1.005)	0.0[a]	0.628E-4[a] (0.373)	-0.0107 (-1.141)	0.0[a]	[illegible][a] [illegible]
N of OBS	2918	2918	2918	2918	2918	2918
Log L	-654.560	-655.222	-655.260	-654.755	-655.454	-655.460

Note:
a. Parameter constrained.

Table 9.6. Probit Regressions for Probability of Participation in Mixed Activity: Day Trips

Variable/Model	MMOD1	MMOD2	MMOD3	MMOD4	MMOD5	MMOD6
Constant	-5.325 (-3.715)	-5.200 (-4.106)	-5.303 (4.186)	-4.509 (-3.000)	-4.344 (-3.814)	-4.297 (-3.828)
METRO	0.164 (1.365)	0.134 (1.130)	0.129 (1.094)	0.139 (1.168)	0.127 (1.081)	0.124 (1.056)
INC	0.62E-4 (3.116)	0.63E-4 (3.158)	0.63E-4 (3.148)	0.65E-4 (3.171)	0.65E-4 (3.223)	0.65E-4 (3.191)
INCSQ	-0.10E-8 (-2.060)	-0.10E-8 (-2.108)	-0.10E-8 (-2.090)	-0.10E-8 (-2.135)	-0.11E-8 (-2.175)	-0.11E-8 (-2.156)
AGE	-0.00642 (-0.251)	-0.00324 (-0.127)	-0.00283 (-0.111)	-0.00623 (-0.242)	-0.00602 (-0.235)	-0.00543 (-0.212)
AGESQ	-0.00028 (-0.806)	-0.00032 (-0.930)	-0.00033 (-0.937)	-0.00029 (-0.823)	-0.00029 (-0.834)	-0.00030 (-0.850)
MARRIED	-0.030 (0.186)	-0.047 (-0.296)	-0.053 (-0.337)	-0.049 (-0.307)	-0.0456 (-0.287)	-0.0486 (-0.306)
SUMEMP	-0.297 (-2.340)	-0.292 (-2.327)	-0.289 (-2.307)	-0.283 (-2.219)	-0.273 (-2.163)	-0.270 (-2.141)
FAMSIZE	-0.0105 (-0.345)	-0.0160 (-0.531)	-0.0151 (-0.500)	-0.0125 (-0.402)	-0.0145 (-0.468)	-0.0135 (-0.437)
SEX	0.179 (1.498)	0.183 (1.544)	0.181 (1.532)	0.162 (1.353)	0.165 (1.385)	0.162 (1.359)
NEAST	0.250 (0.919)	-0.035 (-0.153)	-0.061 (-0.283)	0.013 (0.051)	-0.066 (-0.299)	-0.048 (-0.222)
NCENT	0.0328 (0.204)	0.162 (1.118)	0.163 (1.106)	0.329 (1.884)	0.323 (2.062)	0.282 (1.812)
WEST	0.430 (2.001)	0.497 (2.518)	0.488 (2.474)	0.694 (2.657)	0.591 (2.882)	0.523 (2.627)
SUMMRSUN	0.0517 (2.696)	0.0504 (3.019)	0.0509 (3.037)	0.0625 (2.674)	0.0575 (3.383)	0.0549 (3.296)
SWFUDENS	5.345 (1.257)	-1.044 (-0.385)	[illegible][a] [illegible]			
SWFPDENS	-21.109 (-2.087)	0.0[a]	-0.480[a]			
BOFUDENS	4.581 (0.763)	12.956 (2.952)	12.452[a] (2.649)			
BOFPDENS	100.120 (1.516)	0.0[a]	-2.452[a] (2.649)			
SWFUDIST				-0.0343 (-0.699)	-0.0501 (-1.049)	[illegible][a] (1.377)
SWFPDIST				-0.0828 (-0.569)	0.0[a]	[illegible][a] (1.377)
BOFUDIST				-0.162 (-2.756)	-0.124 (-3.595)	-0.089[a] [illegible]
BOFPDIST				0.167 (0.946)	0.0[a]	-0.089[a] (-3.156)
SWMUDIST	-0.49E-4 (-0.120)	-0.00013 (-0.481)	[illegible][a] [illegible]	-0.00020 (-0.470)	-0.71E-4 (-0.286)	[illegible][a] (0.297)
SWMPDIST	0.00103 (0.077)	0.0[a]	[illegible][a] [illegible]	0.00826 (0.607)	0.0[a]	[illegible][a] (0.297)
BOMUDIST	-0.00209 (-2.529)	-0.00173 (-2.982)	[illegible][a] [illegible]	-0.00214 (-2.394)	-0.00143 (-2.641)	[illegible][a] (-2.951)
BOMPDIST	0.0139 (0.948)	0.0[a]	[illegible][a] [illegible]	0.0214 (1.306)	0.0[a]	[illegible][a] (-2.951)
N of OBS	2186	2186	[illegible]	2186	2186	2186
Log L	-327.516	-330.384	[illegible]	-324.375	-325.986	-326.293

Note:
a. Parameter constrained.

Table 9.7. Probit Regressions for Probability of Participation in Mixed Activity: Overnight Trips

Variable/Model	MMOD7	MMOD8	MMOD9	MMOD10	MMOD11	MMOD12
Constant	-1.881 (-1.579)	-1.549 (-1.463)	-1.437 (-1.375)	0.0921 (0.081)	-0.675 (-0.726)	-0.705 (-0.760)
METRO	0.0563 (0.610)	0.0545 (0.596)	0.0599 (0.657)	0.0339 (0.370)	0.0394 (0.431)	0.0455 (0.499)
INC	0.36E-4 (2.388)	0.35E-4 (2.347)	0.35E-4 (2.313)	0.37E-4 (2.457)	0.35E-4 (2.329)	0.35E-4 (2.315)
INCSQ	-0.44E-9 (-1.220)	-0.43E-9 (-1.213)	-0.42E-9 (-1.190)	-0.46E-9 (-1.279)	-0.43E-9 (-1.205)	-0.43E-9 (-1.200)
AGE	-0.0318 (-1.933)	-0.0310 (-1.888)	-0.0309 (-1.891)	-0.0324 (-1.963)	-0.0315 (-1.924)	-0.0313 (-1.917)
AGESQ	0.000137 (0.685)	0.000126 (0.630)	0.000127 (0.637)	0.000143 (0.712)	0.000132 (0.664)	0.000131 (0.658)
MARRIED	0.0957 (0.767)	0.0930 (0.747)	0.0917 (0.737)	0.0978 (0.782)	0.0950 (0.764)	0.0925 (0.745)
SUMEMP	-0.0793 (-0.804)	-0.0678 (-0.691)	-0.0669 (-0.683)	-0.0776 (-0.784)	-0.0706 (-0.718)	-0.0698 (-0.710)
FAMSIZE	-0.0229 (-0.952)	-0.0244 (-1.017)	-0.0238 (-0.990)	-0.0200 (-0.817)	-0.0217 (-0.896)	-0.0224 (-0.927)
SEX	0.115 (1.204)	0.111 (1.174)	0.111 (1.173)	0.110 (1.150)	0.109 (1.148)	0.108 (1.142)
NEAST	0.184 (0.797)	0.057 (0.316)	0.121 (0.714)	0.018 (0.096)	0.087 (0.511)	0.121 (0.719)
NCENT	0.0893 (0.703)	0.137 (1.162)	0.120 (1.002)	0.240 (1.742)	0.160 (1.277)	0.136 (1.094)
WEST	0.274 (1.421)	0.223 (1.233)	0.193 (1.073)	0.581 (2.407)	0.324 (1.703)	0.258 (1.409)
SUMMRSUN	0.00819 (0.502)	0.00392 (0.277)	0.00254 (0.180)	-0.00488 (-0.289)	0.00123 (0.089)	0.0082 (0.060)
SWFUDENS	4.726 (1.461)	2.772 (1.290)	3.467[a] (1.308)			
SWFPDENS	-6.668 (-0.879)	0.0[a]	-3.467[a]			
BOFUDENS	3.211 (0.683)	5.209 (1.421)	3.900[a] (0.977)			
BOFPDENS	43.272 (0.811)	0.0[a]	-3.900[a] (0.977)			
SWFUDIST				-0.0611 (-1.820)	-0.0546 (-1.808)	[illegible]
SWFPDIST				0.0826 (0.869)	0.0[a]	[illegible]
BOFUDIST				-0.0658 (-1.439)	-0.0247 (-1.008)	[illegible]
BOFPDIST				0.0803 (0.606)	0.0[a]	[illegible]
SWMUDIST	-0.000479 (-1.764)	-0.000254 (-1.275)	-0.000206[a] (-1.053)	-0.000447 (-1.448)	-0.000145 (-0.755)	[illegible]
SWMPDIST	0.0121 (1.298)	0.0[a]	-0.000206[a] (-1.053)	0.00981 (0.998)	0.0[a]	[illegible]
BOMUDIST	-0.000128 (-0.285)	0.000338 (1.599)	0.000326[a] (1.545)	-0.26E-4 (-0.055)	0.000327 (1.574)	[illegible]
BOMPDIST	0.00347 (0.398)	0.0[a]	0.000326[a] (1.545)	0.0188 (1.689)	0.0[a]	[illegible]
N of OBS	2186	2186	2186	2186	2186	[illegible]
Log L	-527.630	-528.982	-529.013	-525.949	-528.200	[illegible]

Note:
a. Parameter constrained.

Table 9.8. OLS on Natural Logarithms of Positive Day Trips for Swimming

Variable/Model	SMOD1	SMOD2	SMOD3	SMOD4	SMOD5	SMOD6
CONSTANT	1.089 (1.009)	0.421 (0.417)	0.519 (0.516)	0.674 (0.630)	0.238 (0.234)	0.380 (0.376)
METRO	-0.408 (-3.751)	-0.416 (-3.817)	-0.408 (-3.743)	-0.392 (-3.602)	-0.388 (-3.572)	-0.388 (-3.560)
INC	-1.940E-5 (-0.955)	-2.106E-5 (-1.035)	-2.167E-5 (-1.065)	-2.100E-5 (-1.033)	-2.241E-5 (-1.106)	-2.179E-5 (-1.074)
INCSQ	1.468E-9 (2.671)	1.521E-9 (2.772)	1.535E-9 (2.797)	1.541E-9 (2.808)	1.533E-9 (2.801)	1.512E-9 (2.759)
AGE	-0.0167 (-0.636)	-0.0181 (-0.688)	-0.0176 (-0.670)	-0.0178 (-0.678)	-0.0182 (-0.693)	-0.0182 (-0.691)
AGESQ	1.766E-4 (0.490)	1.972E-4 (0.546)	1.900E-4 (0.526)	1.880E-4 (0.522)	1.961E-4 (0.544)	1.948E-4 (0.540)
MARRIED	0.0785 (0.482)	0.0748 (0.459)	0.0761 (0.466)	0.0961 (0.590)	0.0836 (0.514)	0.0779 (0.479)
SUMEMP	0.285 (2.612)	0.302 (2.766)	0.302 (2.765)	0.286 (2.617)	0.298 (2.739)	0.297 (2.724)
FAMSIZE	-0.0315 (-1.121)	-0.0356 (-1.265)	-0.0365 (-1.297)	-0.0394 (-1.390)	-0.0417 (-1.477)	-0.0394 (-1.400)
SEX	-0.0085 (-0.079)	-0.0127 (-0.118)	-0.0105 (-0.098)	-0.0075 (-0.070)	-0.0072 (-0.067)	-0.0068 (-0.064)
NEAST	0.147 (0.658)	0.357 (1.779)	0.419 (2.290)	-0.381 (1.905)	0.530 (3.147)	0.501 (3.007)
NCENT	0.185 (1.340)	0.201 (1.459)	0.205 (1.482)	0.196 (1.410)	0.220 (1.612)	0.225 (1.635)
WEST	0.455 (2.081)	0.357 (1.670)	0.352 (1.643)	0.317 (1.348)	0.277 (1.287)	0.331 (1.544)
SUMMRSUN	0.0056 (0.390)	0.0156 (1.177)	0.0149 (1.117)	0.0078 (0.531)	0.0156 (1.182)	0.0143 (1.078)
SWFUDENS	-1.358 (-0.498)	1.462 (0.617)	0.359[a] (0.167)			
SWFPDENS	9.448 (1.790)	0.0[a]	-0.359[a] (0.167)			
SWFUDIST				0.0643 (1.573)	0.0578 (1.430)	0.0375[a] (1.099)
SWFPDIST				0.0282 (0.317)	0.0[a]	0.0375[a] (1.099)
SWMUDIST	-2.389E-4 (-1.021)	8.049E-6 (0.041)	4.525E-6[a] (-0.024)	-2.941E-4 (-1.210)	-1.470E-4 (-0.705)	-1.109E-4[a] (-0.536)
SWMPDIST	0.00811 (1.961)	0.0[a]	4.525E-6[a] (-0.024)	0.0048 (1.414)	0.0[a]	-1 .109E-4[a] (-0.536)
N of OBS	433	433	433	433	433	433
F	3.905	4.111	4.083	3.865	4.238	4.173
R	0.1388	0.1296	0.1289	0.1375	0.1331	0.1313

Note:
a. Parameter constrained.

Table 9.9. OLS on Natural Logarithms of Positive Overnight Trips for Swimming

Variable/Model	SMOD7	SMOD8	SMOD9	SMOD10	SMOD11	SMOD12
CONSTANT	1.043 (1.555)	1.120 (1.784)	1.087 (1.748)	1.064 (1.585)	1.0351 (1.633)	0.987 (1.569)
METRO	-0.0443 (-0.619)	-0.0334 (-0.473)	-0.0385 (-0.544)	-0.0410 (-0.577)	-0.0328 (-0.464)	-0.0363 (-0.514)
INC	2.572E-6 (0.229)	3.557E-6 (0.319)	2.753E-6 (0.246)	2.833E-6 (0.253)	3.877E-6 (0.348)	3.371E-6 (0.303)
INCSQ	5.502E-11 (0.211)	3.426E-11 (0.132)	5.031E-11 (0.193)	5.327E-11 (0.204)	2.734E-11 (0.105)	3.845E-11 (0.148)
AGE	-0.0029 (-0.227)	-0.0031 (-0.244)	-0.0030 (-0.233)	-0.0027 (-0.209)	-0.0032 (-0.247)	-0.0029 (-0.223)
AGESQ	1.909E-5 (0.118)	1.929E-5 (0.119)	1.724E-5 (0.107)	1.512E-5 (0.093)	1.985E-5 (0.123)	1.559E-5 (0.096)
MARRIED	-0.0735 (-0.766)	-0.0639 (-0.669)	-0.0715 (-0.746)	-0.0724 (-0.755)	-0.0613 (-0.645)	-0.0669 (-0.702)
SUMEMP	0.0611 (0.903)	0.0579 (0.858)	0.0587 (0.872)	0.0617 (0.913)	0.0593 (0.878)	0.0608 (0.902)
FAMSIZE	0.0045 (0.244)	0.0060 (0.327)	0.0045 (0.244)	0.0044 (0.233)	0.0058 (0.314)	0.0041 (0.223)
SEX	-0.0571 (-0.868)	-0.0587 (-0.896)	-0.0571 (-0.871)	-0.0556 (-0.844)	-0.0602 (-0.918)	-0.0585 (-0.893)
NEAST	-0.0911 (-0.621)	-0.0613 (-0.481)	-0.0396 (-0.343)	-0.0786 (-0.596)	-0.0791 (-0.734)	-0.0609 (-0.577)
NCENT	-0.0398 (-0.436)	-0.0506 (-0.568)	-0.0416 (-0.462)	-0.0351 (-0.383)	-0.0545 (-0.611)	-0.0474 (-0.530)
WEST	-0.0207 (-0.158)	-0.0463 (-0.361)	-0.0399 (-0.313)	-0.0195 (-0.138)	-0.0559 (-0.414)	-0.0574 (-0.444)
SUMMRSUN	-0.0090 (-0.970)	-0.0102 (-1.180)	-0.0092 (-1.061)	-0.0105 (-1.095)	-0.0010 (-1.161)	-0.0099 (-1.139)
SWFUDENS	-0.795 (-0.453)	-0.596 (-0.388)	-1.072[a] (-0.822)			
SWFPDENS	2.887 (0.856)	0.0[a]	1.072[a] (-0.822)			
SWFUDIST				0.00061 (0.215)	0.00896 (0.318)	0.0176[a] (0.759)
SWFPDIST				0.0470 (0.823)	0.0[a]	0.0176[a] (0.759)
SWMUDIST	-1.546E-4 (-0.812)	-1.346E-4 (-0.798)	-1.451E-4[a] (-0.897)	-1.710E-4 (-0.872)	-1.349E-4 (-0.788)	-1 .666E-4[a] (-0.985)
SWMPDIST	5.183E-4 (0.187)	0.0[a]	-1.451E-4[a] (-0.897)	-1.787E-4 (-0.079)	0.0[a]	-1 .666E-4[a] (-0.985)
N of OBS	333	333	333	333	333	333
F	0.596	0.609	0.650	0.594	0.605	0.643
R	0.0313	0.0282	0.0300	0.0313	0.0280	0.0297

Note:
a. Parameter constrained.

Table 9.10. OLS on Natural Logarithms of Positive Day Trips for Boating

Variable/Model	BMOD1	BMOD2	BMOD3	BMOD4	BMOD5	BMOD6
CONSTANT	2.550 (1.844)	2.445 (1.815)	2.402 (1.785)	2.784 (2.153)	2.546 (2.079)	2.613 (2.143)
METRO	0.237 (1.568)	0.231 (1.539)	0.233 (1.553)	0.252 (1.646)	0.251 (1.660)	0.253 (1.674)
INC	2.152E-5 (0.868)	2.225E-5 (0.899)	2.255E-5 (0.912)	2.461E-5 (0.990)	2.475E-5 (1.000)	2.500E-5 (1.011)
INCSQ	-4.462E-10 (-0.849)	-4.900E-10 (-0.935)	-4.928E-10 (-0.942)	-5.278E-10 (-1.003)	-5.331E-10 (-1.018)	-5.363E-10 (-1.025)
AGE	0.0614 (1.980)	0.0565 (1.838)	0.0569 (1.851)	0.0592 (1.917)	0.0583 (1.897)	0.0588 (1.915)
AGESQ	-6.570E-4 (-1.666)	-6.007E-4 (-1.534)	-6.053E-4 (-1.545)	-6.325E-4 (-1.608)	-6.220E-4 (-1.590)	-6.283E-4 (-1.606)
MARRIED	-0.241 (-1.165)	-0.215 (-1.044)	-0.218 (-1.057)	-0.220 (-1.064)	-0.229 (-1.113)	-0.227 (-1.107)
SUMEMP	0.154 (0.857)	0.146 (0.812)	0.148 (0.826)	0.169 (0.936)	0.162 (0.902)	0.166 (0.926)
FAMSIZE	-0.0216 (-0.497)	-0.0238 (-0.548)	-0.0236 (-0.544)	-0.0276 (-0.631)	-0.0253 (-0.583)	-0.0262 (-0.606)
SEX	-0.342 (-1.968)	-0.333 (-1.922)	-0.332 (-1.915)	-0.349 (-1.991)	-0.334 (-1.942)	-0.340 (-1.975)
NEAST	0.133 (0.473	0.0762 (0.274)	0.0831 (0.299)	0.123 (0.441)	0.112 (0.402)	0.120 (0.431)
NCENT	-0.108 (-0.511)	-0.198 (-0.988)	-0.192 (-0.951)	-0.107 (-0.496)	-0.134 (-0.633)	-0.120 (-0.562)
WEST	0.346 (1.441)	0.324 (1.483)	0.334 (1.525)	0.362 (1.289)	0.383 (1.693)	0.376 (1.695)
SUMMRSUN	-0.0446 (-2.550)	-0.0414 (-2.515)	-0.0413 (-2.510)	-0.0433 (-2.405)	-0.0385 (-2.353)	-0.0398 (-2.477)
BOFUDENS	6.433 (0.981)	2.574 (0.439)	3.382[a] (0.556)			
BOFPDENS	-91.612 (-1.278)	0.0[a]	-3.382[a] (0.556)			
BOFUDIST				-0.0275 (-0.508)	-0.0428 (-1.054)	-0.0395[a] (-1.158)
BOFPDIST				-0.100 (-0.519)	0.0[a]	-0.0395[a] (-1.158)
BOMUDIST	8.332E-4 (2.171)	9.083E-4 (2.471)	9.089E-4[a] (2.493)	8.578E-4 (2.100)	9.688E-4 (2.610)	9. 81E-4[a] (2.583)
BOMPDIST	0.00367 (0.213)	0.0[a]	9.089E-4[a] (2.493)	0.00441 (0.245)	0.0[a]	9. 81E-4[a] (2.583)
N of OBS	198	198	198	198	198	198
F	1.545	1.638	1.649	1.520	1.708	1.727
R	0.1299	0.1213	0.1220	0.1280	0.1258	0.1270

Notes:
a. Parameters constrained.

Table 9.11. OLS on Natural Logarithms of Positive Overnight Trips for Boating

Variable/Model	BMOD7	BMOD8	BMOD9	BMOD10	BMOD11	BMOD12
CONSTANT	0.515 (0.886)	0.585 (1.010)	0.622 (1.077)	-0.128 (-0.239)	0.184 (0.337)	0.174 (0.321)
METRO	0.114 (1.349)	0.125 (1.475)	0.124 (1.460)	0.122 (1.498)	0.120 (1.399)	0.116 (1.371)
INC	4.918E-6 (0.394)	3.713E-7 (0.030)	7.704E-7 (0.062)	7.252E-6 (0.603)	2.127E-6 (0.169)	3.632E-6 (0.290)
INCSQ	-2.396E-10 (-0.909)	-1.416E-10 (-0.540)	-1.509E-10 (-0.577)	-2.717E-10 (-1.074)	-1.641E-10 (-0.619)	-1.890E-10 (-0.718)
AGE	0.0208 (1.452)	0.0191 (1.327)	0.0192 (1.336)	0.0166 (1.199)	0.0191 (1.315)	0.0191 (1.327)
AGESQ	-2.480E-4 (-1.424)	-2.214E-4 (-1.265)	-2.223E-4 (-1.273)	-1.932E-4 (-1.146)	-2.254E-4 (-1.277)	-2.246E-4 (-1.284)
MARRIED	-0.149 (-1.442)	-0.149 (-1.424)	-0.147 (-1.406)	-0.174 (-1.730)	-0.153 (-1.450)	-0.144 (-1.372)
SUMEMP	0.314 (3.560)	0.364 (4.260)	0.356 (4.160)	0.282 (3.314)	0.367 (4.213)	0.344 (3.945)
FAMSIZE	-0.0032 (-0.122)	0.0077 (0.298)	0.0065 (0.255)	-0.0075 (-0.296)	0.0092 (0.354)	0.0051 (0.199)
SEX	-0.291 (-3.452)	-0.287 (-3.375)	-0.287 (-3.390)	-0.257 (-3.146)	-0.290 (-3.383)	-0.289 (-3.398)
NEAST	-0.395 (-2.719)	-0.334 (-2.329)	-0.343 (-2.386)	-0.362 (-2.585)	-0.327 (-2.235)	-0.353 (-2.435)
NCENT	-0.319 (-2.735)	-0.240 (-2.168)	-0.247 (-2.231)	-0.302 (-2.687)	-0.245 (-2.152)	-0.271 (-2.387)
WEST	-0.373 (-3.115)	-0.338 (-3.144)	-0.341 (-3.175)	-0.151 (-1.165)	-0.334 (-2.980)	-0.345 (-3.178)
SUMMRSUN	-0.00436 (-0.569)	-0.00630 (-0.841)	-0.00658 (-0.882)	0.00242 (0.315)	-0.00568 (-0.740)	-0.00656 (-0.875)
BOFUDENS	-9.665 (-2.899)	-6.478 (-2.133)	-7.278[a] (-2.314)			
BOFPDENS	75.501 (2.099)	0.0[a]	7.278[a] (2.314)			
BOFUDIST				-0.0184 (-0.886)	0.0263 (1.404)	0.0356[a] (2.190)
BOFPDIST				0.362 (4.325)	0.0[a]	0.3356[a] (2.190)
BOMUDIST	4.839E-4 (2.799)	4.478E-4 (2.678)	4.373e-4[a] (2.636)	6.680E-4 (3.744)	4.449E-4 (2.540)	4.190E-4[a] (2.480)
BOMPDIST	-0.00614 (-0.599)	0.0[a]	4.373E-4[a] (2.636)	0.00276 (0.274)	0.0[a]	4.190E-4[a] (2.480)
N of OBS	177	177	177	177	177	177
F	3.680	3.764	3.830	4.589	3.538	3.781
R	0.2863	0.2633	0.2667	0.3334	0.2514	0.2641

Note:
a. Parameter constrained.

Table 9.12. OLS on Natural Logarithms of Positive Day Trips for Mixed Activity Purposes

Variable/Model	MMOD1	MMOD2	MMOD3	MMOD4	MMOD5	MMOD6
CONSTANT	9.117 (1.946)	7.164 (1.868)	6.969 (1.842)	5.346 (1.338)	4.714 (1.492)	5.210 (1.635)
METRO	-0.745 (-2.331)	-0.517 (-1.719)	-0.506 (-1.685)	-0.656 (1.973)	-0.500 (-1.691)	-0.485 (-1.634)
INC	2.844E-5 (0.477)	9.213E-6 (0.159)	1.202E-5 (0.208)	2.162E-5 (0.343)	2.232E-5 (0.386)	2.648E-5 (0.454)
INCSQ	-1.111E-9 (-0.702)	-5.280E-10 (-0.347)	-6.056E-10 (-0.398)	-9.632E-10 (-0.564)	-9.215E-10 (-0.597)	-9.580E-10 (-0.615)
AGE	-0.0335 (-0.438)	-0.00609 (-0.083)	0.00128 (0.017)	-0.0367 (-0.465)	-0.012 (-0.162)	-0.0018 (-0.025)
AGESQ	4.394E-4 (0.400)	3.386E-5 (0.032)	-7.369E-5 (-0.070)	5.122E-4 (0.453)	1.067E-4 (0.101)	-3.458E-5 (-0.033)
MARRIED	-0.315 (-0.666)	-0.406 (-0.860)	-0.426 (-0.909)	-0.282 (-0.579)	-0.354 (-0.751)	-0.408 (-0.869)
SUMEMP	0.479 (1.227)	0.242 (0.677)	0.199 (0.552)	0.446 (1.106)	0.261 (0.729)	0.216 (0.596)
FAMSIZE	0.0764 (0.824)	0.0985 (1.064)	0.096 (1.044)	0.100 (1.042)	0.114 (1.223)	0.108 (1.156)
SEX	-0.980 (-2.918)	-0.830 (-2.647)	-0.795 (-2.538)	-1.028 (-2.939)	-0.847 (-2.717)	-0.795 (-2.545)
NEAST	0.690 (0.922)	1.124 (1.785)	0.922 (1.542)	1.051 (1.545)	0.989 (1.636)	0.815 (1.356)
NCENT	0.0023 (0.005)	-0.390 (-1.017)	-0.341 (-0.897)	-0.523 (-1.158)	-0.542 (-1.279)	-0.450 (-1.092)
WEST	-0.871 (-1.491)	-0.913 (-2.003)	-0.802 (-1.716)	-1.235 (-1.941)	-0.941 (-2.095)	-0.791 (-1.722)
SUMMRSUN	-0.0834 (-1.364)	-0.062 (-1.268)	-0.062 (-1.259)	-0.0618 (-0.905)	-0.0569 (-1.177)	-0.0636 (-1.301)
SWFUDENS	-20.413 (-1.576)	-9.087 (-1.228)	-11.135[a] (-1.342)			
SWFPDENS	35.771 (1.342)	0.0[a]	11.135[a]			
BOFUDENS	6.640 (0.368)	-9.945 (-0.814)	-6.143[a] (-0.482)			
BOFPDENS	-274.689 (-1.375)	0.0[a]	6.143[a] (-0.482)			
SWFUDIST				0.183 (1.089)	0.238 (1.664)	[illegible]
SWFPDIST				-0.060 (-0.167)	0.0[a]	[illegible]
BOFUDIST				0.114 (0.657)	0.0461 (0.510)	[illegible]
BOFPDIST				-0.0533 (-0.100)	0.0[a]	[illegible]
SWMUDIST	0.00218 (1.981)	7.453E-4 (1.132)	5./379E-4[a] (0.819)	0.00185 (1.378)	4.302E-4 (0.687)	[illegible]
SWMPDIST	-0.0653 (-1.644)	0.0[a]	5. 379E-4[a] (0.819)	-0.0611 (-1.406)	0.0[a]	[illegible]
BOMUDIST	0.00101 (0.405)	-0.00124 (-0.647)	-9.317E-4[a] (-0.524)	4.965E-4 (0.185)	-0.00158 (-0.822)	[illegible]
BOMPDIST	-0.00815 (-0.162)	0.0[a]	-9.317E-4[a] (-0.524)	-0.0112 (-0.200)	0.0[a]	[illegible]
N of OBS	81	81	81	81	81	[illegible]
F	2.251	2.462	2.490	2.120	2.564	[illegible]
R	0.4490	0.4030	0.4057	0.4342	0.4128	[illegible]

Note:
a. Parameter constrained.

Table 9.13. OLS on Natural Logarithms of Positive Overnight Trips for Mixed Activity Purposes

Variable/Model	MMOD7	MMOD8	MMOD9	MMOD10	MMOD11	MMOD12
CONSTANT	-1.588 (-1.139)	-1 .632 (-1.351)	-1.633 (-1.385)	-1.853 (-1.412)	-1.798 (-1.694)	-1.728 (-1.645)
METRO	0.0606 (0.599)	0.0586 (0.588)	0.0568 (0.570)	0.0667 (0.669)	0.0638 (0.650)	0.0592 (0.605)
INC	-2.134E-6 (-0.127)	-3.655E-6 (-0.227)	-3.946E-6 (-0.244)	-3.181E-6 (-0.191)	-3.838E-6 (-0.239)	-4.108E-5 (-0.255)
INCSQ	3.723E-10 (1.062)	4.094E-10 (1.208)	4.140E-10 (1.217)	4.056E-10 (1.178)	4.132E-10 (1.227)	4.212E-10 (1.248)
AGE	-0.0225 (-1.004)	-0.0211 (-0.962)	-0.0211 (-0.965)	-0.0199 (-0.888)	-0.0195 (-0.897)	-0.0198 (-0.908)
AGESQ	3.686E-4 (1.266)	3.499E-4 (1.230)	3.516E-4 (1.235)	3.360E-4 (1.159)	3.315E-4 (1.174)	3.330E-4 (1.179)
MARRIED	0.257 (1.694)	0.255 (1.736)	0.254 (1.734)	0.247 (1.610)	0.250 (1.710)	0.254 (1.743)
SUMEMP	-0.260 (-2.219)	-0.245 (-2.175)	-0.245 (-2.177)	-0.256 (-2.172)	-0.235 (-2.097)	-0.233 (-2.067)
FAMSIZE	0.0352 (1.135)	0.0355 (1.161)	0.0357 (1.167)	0.0321 (1.032)	0.0341 (1.117)	0.035 (1.143)
SEX	0.151 (1.369)	0.148 (1.362)	0.148 (1.362)	0.151 (1.368)	0.149 (1.372)	0.148 (1.366)
NEAST	0.245 (1.044)	0.230 (1.157)	0.234 (1.228)	0.295 (1.421)	0.265 (1.403)	0.252 (1.346)
NCENT	0.119 (0.786)	0.141 (1.032)	0.135 (0.972)	0.191 (1.113)	0.189 (1.316)	0.185 (1.298)
WEST	0.222 (1.006)	0.201 (1.038)	0.194 (1.008)	0.247 (0.914)	0.205 (1.049)	0.208 (1.093)
SUMMRSUN	0.0252 (1.383)	0.0265 (1.696)	0.0266 (1.726)	0.0320 (1.676)	0.0302 (1.999)	0.0292 (1.976)
SWFUDENS	1.720 (0.467)	0.253 (0.107)	0.535[a] (0.182)			
SWFPDENS	-2.789 (-0.354)	0.0[a]	-0.535[a]			
BOFUDENS	-1.629 (-0.299)	-0.0183 (-0.005)	-0.395[a] (-0.090)			
BOFPDENS	35.315 (0.567)	0.0[a]	0.395[a] (-0.090)			
SWFUDIST				0.0133 (0.325)	0.0121 (0.346)	0.00329[a] (0.099)
SWFPDIST				-0.0226 (-0.212)	0.0[a]	0.00329[a] (0.099)
BOFUDIST				-0.0309 (-0.568)	-0.0212 (-0.820)	-0.0152[a] (-0.695)
BOFPDIST				0.0464 (0.301)	0.0[a]	-0.0152[a] (-0.695)
SWMUDIST	2.285E-5 (0.069)	4.258E-5 (0.191)	5.227E-5[a] (0.233)	-1.389E-4 (-0.362)	-3.087E-5 (-0.135)	7.374E-0[a] (0.033)
SWMPDIST	-8.060E-4 (-0.060)	0.0[a]	5.227E-5[a] (0.233)	0.0049 (0.334)	0.0[a]	7. 374E-0[a] (0.033)
BOMUDIST	-2.957E-4 (-0.471)	-3.506E-4 (-1.647)	-3.497E-4[a] (-1.633)	-5.246E-4 (-0.767)	-3.443E-4 (-1.628)	-3.557E-4[a] (-1.668)
BOMPDIST	0.00553 (0.508)	0.0[a]	-3.497E-4[a] (-1.633)	0.00405 (0.322)	0.0[a]	-3. 557E-4[a] (-1.668)
N of OBS	156	156	156	156	156	156
F	1.085	1.344	1.343	1.120	1.391	1.376
R	0.1454	0.1420	0.1420	0.1493	0.1463	0.1449

Note:
a. Parameter constrained.

activity. Most disappointing, the availability measures, whether in density or price form, seldom have significant parameters and even less frequently are these of the proper sign. Thus, the pollution density correction variable for swimming performs well in the mixed day trip probit equations. The local freshwater distance transform gross of pollution performs well in day swimming, overnight swimming and overnight mixed activity probit equations. The distance increment variable for pollution performs well in the day swimming probits. And the local freshwater distance variable, gross of pollution, does well in the mixed activity, day-trip probits. All other availability measures fail in one way or another. These results are summarized in table 9.14. The entries in this table show for each combination of dependent variable (activity type) and equation (probability, intensity) which parameters were significant and in how many of the specifications for each of the relevant cases. It is further indicated when these significant parameters were of the hypothesized sign.

One cannot but be discouraged by these results. Nor should they be surprising, however, for the quality of the data, especially the availability and pollution measures, has already been criticized at length above. Beyond the significance problems, however, the rest of this chapter will face difficulties caused by incorrect if statistically insignificant signs on key variables. Before turning to benefit estimation, however, it will be desirable to consider the matter of choosing among the several alternative sets of parameter restrictions.

Table 9.14 Summary of Coefficient Sign and Significance

Variable Name	Maximum possible sig. coefficients per row	Day Swim				Overnight Swim				Day Boat				Overnight Boat				Day Mixed				Overnight Mixed			
		Probability		Intensity		Probability		Intensity		Probability		Intensity		Probability		Intensity		Probability		Intensity		Probability		Intensity	
		#	sign	#	sign	#	sign	#	sign	#	sign	#	sign	#	sign	#	sign	#	sign	#	sign	#	sign	#	sign
Metro	6	0		6	-	6	+	0		6	-	3	+	0		0		0		5	-	0		0	
IMC	6	2	+[a]	0		6	+[a]	0		6	+[a]	0		0		0		6	+[a]	0		6	+[a]	0	
IMCSQ	6	0		6	+	0		0		6	-[a]	0		0		0		6	-[a]	0		0		0	
SUMMRSUN	6	0		0		0		0		0		6	-	5		0		6	+	0		0		5	+
SWFUDENS	3	1	+[a]	0		0		0		NA		NA		NA		NA		0		0		0		0	
SWFPDENS	2[b]	0		1	+	0		0		NA		NA		NA		NA		1	-[a]	0		0		0	
SWFUDIST	3	3	-[a]	0		2	-[a]	0		NA		NA		NA		NA		0		1	+	2	-[a]	0	
SWFPDIST	2[b]	1	-[a]	0		1	+	0		NA		NA		NA		NA		0		0		0		0	
SWMUDIST	6	0		0		3	-[a]	0		NA		NA		NA		NA		0		0		1	-[a]	0	
SWMPDIST	4[b]	1	-[a]	1	+	2	-[a]	0		NA		NA		NA		NA		0		1	-[a]	0		0	
BOFUDENS	3	NA		NA		NA		NA		0		0		0		3	-	2	+[a]	0		0		0	
BOFPDENS	2[b]	NA		NA		NA		NA		0		0		0		2	+	1	+	0		0		0	
BOFUDIST	3	NA		NA		NA		NA		0		0		0		1	+	3	-[a]	0		0		0	
BOFPDIST	2[b]	NA		NA		NA		NA		0		0		0		2	+	1	-[a]	0		0		0	
BOMUDIST	6	NA		NA		NA		NA		0		0		0		6	+	6	-[a]	0		0		2	-[a]
BOMPDIST	4[b]	NA		NA		NA		NA		0		0		0		2	+	2	-[a]	0		1	+	1	-[a]

Notes: [a] These significant coefficients have the expected signs.

[b] The pollution fraction variables are included in 2 models out of 3 for each specification of the availability variables. In the skeptic specification the parameters are constrained to be zero.

Testing the Skeptic, Environmental, and General Model Specifications

Both the skeptic and environmental models are nested within the general model and thus can be tested against the general specification. As they are not nested within each other, we can only assert the validity of one over the other when the general model is rejected in favor of one model but accepted when pitted against the other. If the general model is accepted instead of either restricted model then it is preferred to either, and there is no problem raised by the nonnested nature of the skeptic and environmental models. When both restricted models are accepted in tests against the general model no decision can be made on their relative merits.

Tables 9.15 through 9.20 detail the tests of restricted models. Of the 48 pairs of tests of models described in these tables, in only eight instances do the paired tests result in a consistent choice of models. In fact, only three of these consistent choices are made when testing on the more theoretically correct method of estimation. The skeptical model is chosen in the probit regressions on DAYSWIM using the distance-proxy transformation (see table 9.15), while the general model is chosen for the probit regressions on OVSWIM, also using the distance-proxy transformation. The only instance in which a definite choice is implied when OLS is applied to the logarithm of trips is the OVBOAT model also using the distance-proxy transformation. In just one case of all 48 pairs of tests is the environmentalist model the unambiguous choice. This is the OLS probability of participation model of OVSWIM trips using the untransformed density measure of availability.

9.15. Hypothesis Tests of Restrictions on Probability of Swimming Models

Method of Estimation	Source of Dependent Variable	Freshwater Availability Measure	H_1	H_0	Value of Test Statistic	Decision[a]
OLS	DAYSWIM	Acres/Acre	SMOD1	SMOD2	2.36	Accept H_0
			SMOD1	SMOD3	2.35	Accept H_0
OLS	DAYSWIM	$(Acres/Acre)^{-1/2}$	SMOD4	SMOD5	1.85	Accept H_0
			SMOD4	SMOD6	3.82	Reject H_0
OLS	OVSWIM	Acres/Acre	SMOD7	SMOD8	3.50	Reject H_0
			SMOD7	SMOD9	2.66	Accept H_0
OLS	OVSWIM	$(Acres/Acre)^{-1/2}$	SMOD10	SMOD11	5.26	Reject H_0
			SMOD10	SMOD12	7.72	Reject H_0
PROBIT	DAYSWIM	Acres/Acre	SMOD1	SMOD2	4.26	Accept H_0
			SMOD1	SMOD3	4.04	Accept H_0
PROBIT	DAYSWIM	$(Acres/Acre)^{-1/2}$	SMOD4	SMOD5	3.06	Accept H_0
			SMOD4	SMOD6	7.58	Reject H_0
PROBIT	OVSWIM	Acres/Acre	SMOD7	SMOD8	3.90	Accept H_0
			SMOD7	SMOD9	2.74	Accept H_0
PROBIT	OVSWIM	$(Acres/Acre)^{-1/2}$	SMOD10	SMOD11	8.12	Reject H_0
			SMOD10	SMOD12	13.19	Reject H_0

Note:

a. Critical value for F-Test on OLS restrictions is 2.99 for 2 df and significance of 0.05. Critical value for X^2-test on PROBIT restrictions is 5.99 from 2 df and significance of 0.05.

Table 9.16. Hypothesis Test of Restrictions on Probability of Boating Models

Method of Estimation	Source of Dependent Variable	Freshwater Availability Measure	H_1	H_0	Value of Test Statistic	Decision[a]
OLS	DAYBOAT	Acres/Acre	BMOD1	BMOD2	0.72	Accept H_o
			BMOD1	BMOD3	0.76	Accept H_o
OLS	DAYBOAT	$(\text{Acres/Acre})^{-1/2}$	BMOD4	BMOD5	0.05	Accept H_o
			BMOD4	BMOD6	0.12	Accept H_o
OLS	OVBOAT	Acres/Acre	BMOD7	BMOD8	0.29	Accept H_o
			BMOD7	BMOD9	0.32	Accept H_o
OLS	OVBOAT	$(\text{Acres/Acre})^{-1/2}$	BMOD10	BMOD11	0.30	Accept H_o
			BMOD10	BMOD12	0.31	Accept H_o
PROBIT	DAYBOAT	Acres/Acre	BMOD1	BMOD2	1.13	Accept H_o
			BMOD1	BMOD3	1.24	Accept H_o
PROBIT	DAYBOAT	$(\text{Acres/Acre})^{-1/2}$	BMOD4	BMOD2	0.02	Accept H_o
			BMOD4	BMOD3	0.08	Accept H_o
PROBIT	OVBOAT	Acres/Acre	BMOD7	BMOD5	1.32	Accept H_o
			BMOD7	BMOD6	1.40	Accept H_o
PROBIT	OVBOAT	$(\text{Acres/Acre})^{-1/2}$	BMOD10	BMOD8	1.40	Accept H_o
			BMOD10	BMOD9	1.41	Accept H_o

Note:

a. Critical value for F-Test on OLS restrictions is 2.99 for 2 df and significance of 0.05. Critical value for χ^2-test on PROBIT restrictions is 5.99 from 2 df and significance of 0.05.

Table 9.17. Hypothesis Test of Restrictions on Probability of Mixed Activity Models

Method of Estimation	Source of Dependent Variable	Freshwater Availability Measure	H_1	H_0	Value of Test Statistic	Decision[a]
OLS	DAYMIXED	Acres/Acre	MMOD1	MMOD2	1.56	Accept H_o
			MMOD1	MMOD3	1.55	Accept H_o
OLS	DAYMIXED	$(\text{Acres/Acre})^{-1/2}$	MMOD4	MMOD5	0.71	Accept H_o
			MMOD4	MMOD6	0.79	Accept H_o
OLS	OVMIXED	Acres/Acre	MMOD7	MMOD8	0.65	Accept H_o
			MMOD7	MMOD9	0.54	Accept H_o
OLS	OVMIXED	$(\text{Acres/Acre})^{-1/2}$	MMOD10	MMOD11	0.77	Accept H_o
			MMOD10	MMOD12	0.93	Accept H_o
PROBIT	DAYMIXED	Acres/Acre	MMOD1	MMOD2	5.74	Accept H_o
			MMOD1	MMOD3	6.48	Accept H_o
PROBIT	DAYMIXED	$(\text{Acres/Acre})^{-1/2}$	MMOD4	MMOD5	3.22	Accept H_o
			MMOD4	MMOD6	3.84	Accept H_o
PROBIT	OVMIXED	Acres/Acre	MMOD7	MMOD8	2.70	Accept H_o
			MMOD7	MMOD9	2.77	Accept H_o
PROBIT	OVMIXED	$(\text{Acres/Acre})^{-1/2}$	MMOD10	MMOD11	4.50	Accept H_o
			MMOD10	MMOD12	5.45	Accept H_o

Note:

a. Critical value for F-test on OLS restrictions is 2.37 for 4 df and significance of 0.05. Critical value for χ^2 test on PROBIT restrictions is 9.49 for 4 df and significance of 0.05.

Table 9.18. Hypothesis Test of Restrictions on Intensity of Swimming Models Given Participation

Method of Estimation	Source of Dependent Variable	Freshwater Availability Measure	H_I	H_0	Value of Test Statistic	Decision[a]
OLS	DAYSWIM	Acres/Acre	SMOD1	SMOD2	2.35	Accept H_o
			SMOD1	SMOD3	2.21	Accept H_o
OLS	DAYSWIM	$(\text{Acres/Acre})^{-1/2}$	SMOD4	SMOD5	1.41	Accept H_o
			SMOD4	SMOD6	1.41	Accept H_o
OLS	OVSWIM	Acres/Acre	SMOD7	SMOD8	2.85	Accept H_o
			SMOD7	SMOD9	0.54	Accept H_o
OLS	OVSWIM	$(\text{Acres/Acre})^{-1/2}$	SMOD10	SMOD11	0.57	Accept H_o
			SMOD10	SMOD12	0.47	Accept H_o
Semilog OLS	DAYSWIM	Acres/Acre	SMOD1	SMOD2	2.18	Accept H_o
			SMOD1	SMOD3	2.36	Accept H_o
Semilog OLS	DAYSWIM	$(\text{Acres/Acre})^{-1/2}$	SMOD4	SMOD5	1.05	Accept H_o
			SMOD4	SMOD6	1.47	Accept H_o
Semilog OLS	OVSWIM	Acres/Acre	SMOD7	SMOD8	0.51	Accept H_o
			SMOD7	SMOD9	0.21	Accept H_o
Semilog OLS	OVSWIM	$(\text{Acres/Acre})^{-1/2}$	SMOD10	SMOD11	0.52	Accept H_o
			SMOD10	SMOD12	0.25	Accept H_o

Note:
a. Critical value of F-test on OLS restrictions is 3.02 for 411 df and (days and long days models) and 3.04 for 312 df (overnights and log overnights models), both at significance level of 0.05.

Table 9.19. Hypothesis Test of Restriction on Intensity of Boating Models Given Participation

Method of Estimation	Source of Dependent Variable	Freshwater Availability Measure	H_1	H_0	Value of Test Statistic	Decision[a]
OLS	DAYBOAT	Acres/Acre	BMOD1	BMOD2	2.68	Accept H_o
			BMOD1	BMOD3	2.62	Accept H_o
OLS	DAYBOAT	$(\text{Acres/Acre})^{-1/2}$	BMOD4	BMOD5	2.96	Accept H_o
			BMOD4	BMOD6	2.79	Accept H_o
OLS	OVBOAT	(Acres/Acre)	BMOD7	BMOD8	3.50	Reject H_o
			BMOD7	BMOD9	3.08	Reject H_o
OLS	OVBOAT	$(\text{Acres/Acre})^{-1/2}$	BMOD10	BMOD11	9.89	Reject H_o
			BMOD10	BMOD12	8.38	Reject H_o
Semilog OLS	DAYBOAT	Acres/Acre	BMOD1	BMOD2	0.86	Accept H_o
			BMOD1	BMOD3	0.79	Accept H_o
Semilog OLS	DAYBOAT	$(\text{Acres/Acre})^{-1/2}$	BMOD4	BMOD5	0.22	Accept H_o
			BMOD4	BMOD6	0.10	Accept H_o
Semilog OLS	OVBOAT	Acres/Acre	BMOD7	BMOD8	2.49	Accept H_o
			BMOD7	BMOD9	2.13	Accept H_o
Semilog OLS	OVBOAT	$(\text{Acres/Acre}^{-1/2}$	BMOD10	BMOD11	9.53	Reject H_o
			BMOD10	BMOD12	8.05	Reject H_o

Note:

a. Critical value of F-test on OLS restrictions is 3.06 for significance level of 0.05 with 175 df (days and long days) or 195 df (overnights and log overnights).

Table 9.20. Hypothesis Test of Restrictions on Intensity of Mixed Activity Models Given Participation

Method of Estimation	Source of Dependent Variable	Freshwater Availability Measure	H_1	H_0	Value of Test Statistic	Decision[a]
OLS	DAYMIXED	Acres/Acre	MMOD1	MMOD2	0.77	Accept H_0
			MMOD1	MMOD3	0.75	Accept H_0
OLS	DAYMIXED	$(\text{Acres/Acre})^{-1/2}$	MMOD4	MMOD5	0.84	Accept H_0
			MMOD4	MMOD6	0.78	Accept H_0
OLS	OVMIXED	Acres/Acre	MMOD7	MMOD8	0.04	Accept H_0
			MMOD7	MMOD9	0.02	Accept H_0
OLS	OVMIXED	$(\text{Acres/Acre})^{-1/2}$	MMOD10	MMOD11	0.09	Accept H_0
			MMOD10	MMOD12	0.21	Accept H_0
Semilog OLS	DAYMIXED	Acres/Acre	MMOD1	MMOD2	1.19	Accept H_0
			MMOD1	MMOD3	1.12	Accept H_0
Semilog OLS	DAYMIXED	$(\text{Acres/Acre})^{-1/2}$	MMOD4	MMOD5	0.54	Accept H_0
			MMOD4	MMOD6	0.66	Accept H_0
Semilog OLS	OVMIXED	Acres/Acre	MMOD7	MMOD8	0.13	Accept H_0
			MMOD7	MMOD9	0.13	Accept H_0
Semilog OLS	OVMIXED	$(\text{Acres/Acre})^{-1/2}$	MMOD10	MMOD11	0.12	Accept H_0
			MMOD10	MMOD12	0.17	Accept H_0

Note:

a. Critical value of F-test on OLS restrictions is 2.54 for 57 df (the days and log days models) and 2.44 for 133 df (the overnights and log overnights models), both at a level of significance of 0.05.

As far as the implications for benefit estimation go, recall that the skeptical model will produce benefit estimates of zero, because a zero parameter value is forced on the parameters of the variables sensitive to the policy instruments for prediction. The environmentalist model (and perhaps the general model as well) will produce positive benefit estimates when the signs are proper, because the parameter signs on the pollution correction variables are negative and the post-policy values of this correction are always zero, thus adding overall to participation probability and intensity. When both restricted models are accepted, only the benefits estimated from the environmentalist model will be reported below, realizing that the skeptic model produces zero benefits.

PROJECTION RESULTS

Probability of Participation

In table 9.21 are reported the pre- and post-policy probabilities of participation in swimming, boating and mixed activities, in day and overnight categories. These reflect the model comparisons just discussed. Table 9.22 summarizes the results of projecting changing probability of participation by activity category. The figures in the table are in millions of participants, the transformation from probability to numbers being via the 1972 civilian non-institutionalized population of the lower 48 states, 208,230,000. It is important to note that using a different population, say 1980 or 1983, would not affect any of the problems discussed below. The effect would only be to raise the positive benefit totals and make more negative, the negative totals. It is conceivable that using two different populations--say, 1972 for pre-policy and 1983 for post-policy--the negative numbers in table 9.21 could be changed to

Table 9.21. Probability of Participation by Activity Category, Availability Measure and Estimation Method

Activity	Availability	Model	Number	Method: Sophisticated Pre-Policy	Sophisticated Post-Policy	Naive Pre-Policy	Naive Post-Policy
Swimming/Day	Density	Env.	SMOD3	0.1228	0.1251	0.1790	0.1811
Swimming/Day	Distance	Skeptic	SMOD5	0.1113	0.1113	0.1685	0.1685
Swimming/Overnight	Density	Env.	SMOD9	0.1213	0.1209	0.1532	0.1514
Swimming/Overnight	Distance	General	SMOD10	0.1049	0.0973	0.1420	0.1344
Boating/Day	Density	Env.	BMOD3	0.0488	0.0490	0.0687	0.0689
Boating/Day	Distance	Env.	BMOD6	0.0483	0.0494	0.0684	0.0694
Boating/Overnight	Density	Env.	BMOD9	0.0509	0.0510	0.0589	0.0590
Boating/Overnight	Distance	Env.	BMOD12	0.0511	0.0512	0.0591	0.0590
Mixed/Day	Density	Env.	MMOD3	0.0201	0.0210	0.0490	0.0513
Mixed/Day	Distance	Env.	MMOD6	0.1540	0.0189	0.0439	0.0500
Mixed/Overnight	Density	Env.	MMOD9	0.0569	0.0605	0.0736	0.0781
Mixed/Overnight	Distance	Env.	MMOD12	0.0519	0.0558	0.0678	0.0724

Table 9.22. Projected Changes in Participation Due to Pollution Control: by Activity, Availability Measure and Method of Estimation

(Millions of participants)

Activity	Availability Measure	Model	#	Probit Pre-Policy	Probit Post-Policy	Probit Change	OLS Pre-Policy	OLS Post-Policy	OLS Change
Swimming/Day	Density	Env.	SMOD3	25.58	26.05	0.47	37.26	37.71	0.45
Swimming/Day	Distance	Skeptic	SMOD5	23.17	23.17	0	35.10	35.10	0
Swimming/Overnight	Density	Env.	SMOD9	25.25	25.18	-0.07	31.91	31.52	-0.39
Swimming/Overnight	Distance	General	SMOD10	21.85	20.26	-1.60	29.56	27.99	-1.57
Boating/Day	Density	Env.	BMOD3	10.16	10.20	0.04	14.31	14.34	0.03
Boating/Day	Distance	Env.	BMOD6	10.05	10.28	0.23	14.24	14.46	0.22
Boating/Overnight	Density	Env.	BMOD9	10.60	10.63	0.03	12.27	12.29	0.02
Boating/Overnight	Distance	Env.	BMOD12	10.65	10.65	0.00	12.30	12.28	-0.02
Mixed/Day	Density	Env.	MMOD3	4.18	4.38	0.20	10.20	10.68	0.48
Mixed/Day	Distance	Env.	MMOD6	3.21	3.93	0.72	9.15	10.39	1.24
Mixed/Overnight	Density	Env.	MMOD9	11.85	12.59	0.74	15.32	16.26	0.94
Mixed/Overnight	Distance	Env.	MMOD12	10.80	11.63	0.83	14.12	15.08	0.96

positive, for the projected decrease in probability might well be offset by the increase in population to which the probability is applied. This question is explored below.

As far as the pattern of results goes, one or two observations are in order. First, it is intuitively appealing to find the negative changes in category of participation involving overnight trips for swimming. One would expect such trips to be less necessary as water pollution control expanded the set of natural waters closer to the average person's home that were available for swimming. Second, it is similarly appealing to find the projected changes in boating so small. This is consistent with the notion, discussed above, that boating is relatively insensitive to pollution, except at very gross levels. Third, it is modestly reassuring to note that the two methods agree rather closely on the projected participation changes even though they disagree on the pre and post-policy totals. In a few cases, as will be seen below, this agreement survives through the calculations required to produce overall participation changes. But in the others, the sophisticated and naive methods give very different overall results.

Intensity of Participation

The results of projecting changes in intensity of participation are summarized in table 9.23. Most noticeably, these results include a disturbingly large fraction of negative numbers: eighteen of twenty four, to be precise. To be sure, the more sophisticated method (using log trips as the dependent variable) shows up less badly, with "only" half the projections being negative, and some of these close to zero. But the five positive projections are also very close to zero; and one projection is effectively zero. The naive method consistently produces negative changes,

Table 9.23. Projected Changes in Intensity of Participation (Days per year per participant) Due to Pollution Control: by Activity, Availability Measure and Method of Estimation

Activity	Availability Measure	Model	#	Days Per Trip	Log Trips Pre-Policy Trips	Log Trips Post-Policy Trips	Log Trips Change in Days	Trips Pre-Policy Trips	Trips Post-Policy Trips	Trips Change in Days
Swimming/Day	Density	Env.	SMOD3	1.00	3.58	3.59	0.01	7.15	7.12	-0.03
Swimming/Day	Distance	Env.	SMOD6	1.00	3.76	3.69	-0.08	7.29	7.19	-0.10
Swimming/Overnight	Density	Env.	SMOD9	4.09	1.30	1.29	-0.03	1.59	1.58	-0.06
Swimming/Overnight	Distance	Env.	SMOD12	4.09	1.31	1.30	-0.04	1.61	1.50	-0.06
Boating/Day	Density	Env.	BMOD3	1.00	2.39	2.39	0.00	5.56	5.53	-0.03
Boating/Day	Distance	Env.	BMOD6	1.00	2.35	2.39	0.04	5.41	5.49	0.08
Boating/Overnight	Density	General, Env.	BMOD9,7[a]	3.26	1.29	1.28	-0.03	1.55	1.42	-0.41
Boating/Overnight	Distance	General	SMOD10	3.26	1.25	1.04	-0.68	1.51	1.05	-1.50
Mixed/Day	Density	Env.	MMOD3	1.00	4.64	4.24	-0.40	11.34	10.62	-0.72
Mixed/Day	Distance	Env.	MMOD6	1.00	5.74	5.07	-0.67	11.94	10.87	-1.07
Mixed Overnight	Density	Env.	MMOD9	9.48	1.55	1.55	0.05	2.01	1.98	-0.32
Mixed Overnight	Distance	Env.	MMOD12	9.48	1.53	1.54	0.09	2.09	2.07	-0.16

a. The general model is preferred for trips; the Environmental Model for log trips.

some rather large. The results will dominate the benefit estimates discussed in the next subsection.

There does not seem to be any “story” one can tell to explain away these results, except to point again to the highly questionable character of the water quality data. One would not expect all varieties of trips to decline, even if one were prepared to see, for example, boating-only trips decline as swimming became more widely possible.

Benefits

In table 9.24 are found the results of combining projected changes in participation probability and intensity with values of swimming and boating days from the recreation literature. The calculation involves multiplying existing (pre-policy) participant numbers by the change in days per participant and adding this quantity to the product of the change in participant numbers (the new participants) and the post-policy days per participant.

Three columns are especially interesting. First, the total change in participation is the quantity measure of the effect of water pollution control. As anticipated by comments in the previous two subsections, this column shows a substantial fraction of overall negative projections. (Thirteen of twenty four entries are negative.) These negatives result for the most part from the projected declines in trips (or in days per year per existing participant). In five cases the effect of trip declines is reinforced by declines in number of participants, but in eight cases, the two parts of the projection work in opposite directions. In a further five cases the signs of the two calculated quantities are opposite but dominated by the positive result.

Table 9.24. Projected Benefits of Water Pollution Control, by Activity Category, Availability Measure, and Estimation Method

Activity	Avail-ability	Models	#s	Estima-tion	Pre-Pol Part (OP) (10^6)	Change in Days per Part. (CD)	Change in Part. (CP)(10^6)	Post-Pol Days per Part. (ND)	Total Chg in Days (OPxCD) + (CDxND)(10^6)	Total Benefits[a] Low[b]	High[b]
										(x10^6$)	
Swimming/Day	Density	Env.	SMOD3	Soph.	25.58	0.01	0.47	3.59	1.95	19.48	54.60
Swimming/Day	Density	Env.	SMOD3	Naive	37.26	-0.03	0.45	7.12	2.08	20.78	58.24
Swimming/Day	Distance	Skep. Env.	SMOD5,6	Soph.	23.17	-0.08	0	3.69	-1.85	-51.80	-18.48
Swimming/Day	Distance	Skep. Env.	SMOD5,6	Naive	35.10	-0.10	0	7.19	-3.51	-98.28	-35.06
Swimming/Overnight	Density	Env.	SMOD9	Soph.	25.25	-0.03	-0.07	5.28	-1.13	-31.64	-11.29
Swimming/Overnight	Density	Env.	SMOD9	Naive	31.91	-0.06	-0.39	6.46	-4.43	-124.04	-44.26
Swimming/Overnight	Distance	Env.	SMOD10,12	Soph.	21.85	-0.04	-1.60	5.32	-9.38	-262.64	-93.71
Swimming/Overnight	Distance	Gen. Env.	SMOD10,12	Naive	29.56	-0.06	-1.57	6.14	-11.41	-319.48	-113.99
Boating/Day	Density	Env.	BMOD3	Soph.	10.16	0.00	0.04	2.39	0.10	0.62	3.42
Boating/Day	Density	Env.	BMOD3	Naive	14.31	-0.03	0.03	5.53	-0.26	-8.90	-1.62
Boating/Day	Distance	Env.	BMOD6	Soph.	10.05	0.04	0.23	2.39	0.95	5.91	32.51
Boating/Day	Distance	Env. Gen.	BMOD6	Naive	14.24	0.08	0.22	5.49	2.35	14.62	80.42
Boating/Overnight	Density	Env.	BMOD9	Soph.	10.60	-0.03	0.03	4.17	-0.19	-6.50	-1.18
Boating/Overnight	Density	Env. Gen.	BMOD9,7	Naive	12.27	-0.41	0.02	4.63	-4.94	-169.05	-30.73
Boating/Overnight	Distance	Env. Gen.	BMOD12,10	Soph.	10.65	-0.68	0.00	3.39	-7.24	-247.75	-45.03
Boating/Overnight	Distance	Gen. Env.	BMOD10,12	Naive	12.30	-1.50	-0.02	3.42	-18.52	-633.75	-115.19
Mixed/Day	Density	Env.	MMOD3	Soph.	4.18	-0.40	0.20	4.24	-0.82	-28.06	-5.10
Mixed/Day	Density	Env.	MMOD3	Naive	10.20	-0.72	0.48	10.62	-2.24	-76.65	-13.93
Mixed/Day	Distance	Env.	MMOD6	Soph.	3.21	-0.67	0.72	5.07	1.50	9.33	51.33
Mixed/Day	Distance	Env.	MMOD6	Naive	9.15	-1.07	1.24	10.87	3.69	22.95	126.27
Mixed/Overnight	Density	Env.	MMOD9	Soph.	11.85	0.05	0.74	14.69	11.46	71.28	392.16
Mixed/Overnight	Density	Env.	MMOD9	Naive	15.32	-0.32	0.94	18.77	12.74	79.24	435.96
Mixed/Overnight	Distance	Env.	MMOD12	Soph.	10.80	0.09	0.83	14.60	13.09	81.42	447.94
Mixed/Overnight	Distance	Env.	MMOD12	Naive	14.12	-0.16	0.96	19.62	16.58	103.13	567.37

Notes:

a. Swimming days are valued at $9.99 and $28.00, the values found in Loomis and Sorg (n.d.) updated from 1972 to 1983 dollars. Boating and mixed days are valued at $6.22 and $34.22, using the same source and inflation correction.

b. For positive net change in days the lower of the per day values is used to obtain the lower bounds on benefit, the higher value to get the upper bounds. When the projected change in days is negative, the opposite rule applies.

The last two columns in 9.24 show low and high benefit estimates (in 1983 dollars) resulting from multiplying the overall participation changes by values of activity days from Loomis and Sorg (n.d.). Note that the low column includes the largest negative projections and the high column the smallest negative numbers. This approach was adopted to stress the range of overall values as discussed below. It means that the low column does not reflect the low per day values only. If the negative entries were reversed in each row where they appear, the overall results would be compressed into a smaller range.

The benefit values for swimming days (day and overnight trigs.) range from minus three hundred and twenty million dollars per year to about plus sixty million dollars per year. Those for boating range from minus six hundred and thirty to plus eighty million. And those for mixed days from minus seventy six million to plus five hundred and seventy million dollars per year.

Certainly both the wide range of uncertainty and the fact that the lower end of each activity's range is firmly anchored on the negative numbers are both disturbing features of this table. The latter is by far the more disturbing, for nothing in theory or intuition prepares us to find negative benefits from pollution control policy. If the negative results were confined entirely to the swimming only and boating only activities, one might begin by hypothesizing that they reflect shifts out of those categories and into the mixed activities as water pollution control upgrades water that was once only boatable into the swimmable category. A quick look at 9.24 suggests that even though the results do not follow this pattern completely, it might still constitute the major explanation.

To explore this possibility, tables 9.25 and 9.26 have been constructed. In the first, the participation changes are combined by availability measure and estimation method to produce four overall figures. If shifts into the mixed activities are behind the negatives, one would expect to find these overall figures all to be positive. Unfortunately they are not. Both density-based overall participation changes are positive. But both distance-based ones are negative. (The apparent symmetry around zero is probably an artifact with no significance.) While three of the four summations show the hypothesized sign pattern for the grouped activities, in only the naive, density-based case is the net result that hypothesized. For both density-based columns, shifts into the mixed activities are too-small to account for the projected shifts out of swimming and boating only.

In table 9.26 the participation changes are first multiplied by values per day and then combined as in 9.24 by availability measure and estimation method to arrive at overall benefit totals. Here 3 of 8 totals are negative and one of these is a huge minus 9 hundred million dollars per year. The positive results vary from 25 million to over half a billion dollars per year. Again, some of the patterns have intuitive appeal. Overnight, single-purpose-trip benefits are negative in every category. In many cases, single-purpose day-trip benefits are also negative. In all categories the combined total for the mixed activity is positive. But, as for the quantity measure alone, this last positive number does not always outweigh the negative sums above it.

Two subsidiary questions might usefully be explored to probe the sensitivity of these results to other parts of the method. First, to what extent are the above results caused by the rule adopted for characterizing

Table 9.25. Overall Changes in Days of Participation by Availability Measure and Estimation Method

(Millions of days per year)

Density Sophisticated

Swimming/Day	1.95	+ 0.82	Swimming
Swimming/Overnight	-1.13		
Boating Day	0.10	- 0.08	Boating
Boating/Overnight	-0.19		
Mixed/Day	-0.82	+ 10.64	Mixed
Mixed/Overnight	11.46		
TOTAL	11.37		

Density Naive

Swimming/Day	2.08	-2.34	Swimming
Swimming/Overnight	-4.43		
Boating Day	-0.26	-5.20	Boating
Boating/Overnight	-4.94		
Mixed/Day	-2.24	+10.50	Mixed
Mixed/Overnight	12.74		
TOTAL	2.95		

Distance Sophisticated

Swimming/Day	-1.85	-11.23	Swimming
Swimming/Overnight	-9.38		
Boating Day	0.95	-6.29	Boating
Boating/Overnight	-7.24		
Mixed/Day	1.50	+14.59	Mixed
Mixed/Overnight	13.03		
TOTAL	-2.93		

Distance Naive

Swimming/Day	-3.51	-14.92	Swimming
Swimming/Overnight	-11.41		
Boating Day	2.35	-16.17	Boating
Boating/Overnight	-18.52		
Mixed/Day	3.69	+20.27	Mixed
Mixed/Overnight	16.58		
TOTAL	-10.82		

Table 9.26. Activity-Specific and Overall Benefits from Pollution Control by Availability Measure, Estimation Method and Value of an Activity Day

(Millions of Dollars per year)

	Density Sophisticated		Density Naive	
	Low	High	Low	High
Swimming/Day	$19.48	$54.60	$20.78	$58.24
Swimming/Overnight	-31.64	-11.29	-124.04	-44.26
Boating/Day	0.62	3.42	-8.90	-1.62
Boating/Overnight	-6.50	-1.18	-169.05	-30.73
Mixed/Day	-28.06	-5.10	-76.65	-13.93
Mixed/Overnight	71.28	392.16	79.24	435.96
TOTAL	$25.18	$432.61	$-278.62	$403.66

	Distance Sophisticated		Distance Naive	
	Low	High	Low	High
Swimming/Day	$-51.80	$-18.48	$-98.28	$-35.06
Swimming/Overnight	-262.64	-93.71	-319.48	-113.99
Boating/Day	5.91	32.51	14.62	80.42
Boating/Overnight	-247.75	-45.03	-633.75	-115.19
Mixed/Day	9.33	51.33	22.95	126.27
Mixed/Overnight	81.42	447.94	103.13	567.37
TOTAL	$-465.53	$374.56	$-910.81	$509.82

benefits by category as high or low. That rule put in the low column the largest negative numbers and in the high column the smallest negative numbers. This is consistent with the meanings of low and high but involves inconsistent application of the per day values. That is, if "low" is identified with the low per day value and "high" with the high one. The range of overall results will at least be reduced. In fact, the range is reduced by about half. In table 9.27, the largest negative number is minus $280 million per year, and the largest positive benefit is about $380 million per year. But note that now instead of three negative totals there are four--all those resulting from the distance version of the availability measure.

The second question is: What happens if a larger post-policy population is used as the basis for participation estimates? The argument here is that by the time there will have been time to implement the policy, population will have grown. For example, using the 1980 U.S. population of about 226.5 million, the total participation figures in millions of days are as summarized in table 9.28. The differences between this table and 9.25 are dramatic. In 9.28 there are no overall negative changes and only two negative changes for specific and aggregative activities (overnight boating and, consequently overall boating activity, using the distance transform of the availability measure). It goes without saying that the resulting monetized benefits would in every case be positive as well. Roughly speaking, such benefits would vary between $290 x 10^6 and $3.0 x 10^9 per year. But before we seize on this as an "answer" to the problem raised by the negative estimates reported first, it is necessary to insert a note of caution. The participation probability and intensity equations estimated on the basis of 1972 do not reflect density of _use_ (crowding).

Table 9.27. Activity Specific and Overall Benefits from Pollution Control by Availability Measure, Estimation Method, and Value of an Activity Day: Reversing Placement of Negative Estimates

(Millions of dollars per year)

	Density Sophisticated		Density Naive	
	Low	High	Low	High
Swimming/Day	$19.48	$54.60	$20.78	$58.24
Swimming/Overnight	-11.29	-31.64	-44.26	-124.04
Boating/Day	0.62	3.42	-1.62	-8.90
Boating/Overnight	-1.18	-6.50	-30.73	-169.05
Mixed/Day	-5.10	-28.06	-13.93	-76.65
Mixed/Overnight	71.28	392.16	79.24	435.96
TOTAL	$73.81	$383.98	$9.48	$115.56

	Distance Sophisticated		Distance Naive	
	Low	High	Low	High
Swimming/Day	$-18.48	$-51.80	$-35.06	$-98.28
Swimming/Overnight	-93.71	-262.64	-113.99	-319.48
Boating/Day	5.91	32.51	14.62	80.42
Boating/Overnight	-45.03	-247.75	-115.19	-633.75
Mixed/Day	9.33	51.33	22.95	126.27
Mixed/Overnight	81.42	447.94	103.13	567.37
TOTAL	$-60.56	$-30.41	$-123.54	$-277.45

Table 9.28. Overall Changes in Days of Participation by Availability Measure and Estimation Method: Post-Policy Population = U.S. Population in 1986

(Millions of days)

	Density Sophisticated		Density Naive	
Swimming/Day	10.17	20.66	25.65	39.11
Swimming/Overnight	10.49		13.46	
Boating/Day	2.25	5.97	6.76	6.78
Boating/Overnight	3.72		0.02	
Mixed/Day	0.79	28.56	7.74	47.32
Mixed/Overnight	27.77		39.58	
TOTAL	55.19		93.21	

	Distance Sophisticated		Distance Naive	
Swimming/Day	5.68	5.82	18.56	22.18
Swimming/Overnight	0.14		3.62	
Boating/Day	3.12	-0.90	9.27	-5.55
Boating/Overnight	-4.02		-14.82	
Mixed/Day	3.27	31.10	13.91	56.38
Mixed/Overnight	27.83		42.47	
TOTAL	36.02		73.01	

This variable, central to the recreational experience, is thus implicitly held equal in the projection exercise. Such an approach seems more defensible the smaller the projected changes in use. But as post-policy population is increased, the projected changes become larger and larger, and thus the possibility for a crowding effect larger and larger. At some point the projections done on this basis must become unreliable, quite apart from the other methodological and data difficulties already discussed. Therefore, it seems desirable to concentrate attention on the benefits estimated using the same pre- and post-policy populations, merely keeping mind that increasing the assumed population increases the benefits, and that it is not necessary for the increase to be very large before negative overall benefits no longer appear. The range between low and high estimates remains very large, however.

CONCLUDING COMMENTS

The above exercise in the application of a two step participation method of benefit estimation has been far from entirely satisfying. The econometric results were weak and the subsequent projections exhibited sign problems and generally unintuitive patterns. While there are certainly methodological problems, as pointed out in Vaughan, *et*. *al*., 1985, it seems likely that here the dominant problem was data quality. In particular, the water quality (availability) data were especially weak, having been generated by state officials on largely unspecified grounds. Certainly these data cannot be taken to represent careful and consistent measurements of objective parameters.

In the course of the chapter, the effect of increasing post-policy population was explored. It was found that using 1980 instead of 1972 population removed all but two negative participation changes at the specific activity level and thus led to uniformly positive overall benefits. The range of uncertainty remained very large--between 280 and 3 billion dollars per year. This "solution" was criticized, however, as inconsistent with the assumptions behind the participation equations.

NOTES

1. In the density form of the participation or intensity equations, we have in general Part = $\beta_i A+\beta_j \rho A$ where the βs are coefficients relating densities (A) to participation, and ρ is the fraction of available acreage available. Then $\partial(\text{Part})/\partial(A) > 0$ and $\partial\text{Part}/\partial\rho < 0$ when $\beta_j < 0$ and $\rho < 1$. Going to the distance (price) form, however, could be done via either the inverses of gross acreage and of the decrement to gross acreage or via net acreage. In the latter case, we would have Part $\cong \beta_k/(A-\rho A)^{1/2}$ and there would be no possibility of reaching conclusions about the effect of ρ separately. The former case becomes:

$$\text{Part} \cong \frac{\beta_\ell}{(A)^{1/2}} + \frac{\beta_m}{\rho(A)^{1/2}}$$

and to have $\partial\text{Part}/\partial A > 0$ and $\partial\text{Part} < 0$ it must be true that $\beta_\ell < 0$ and $\beta_m > 0$.

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